Re-Analyzing Olmec Archaeology: Evaluating Materials from Robert J. Squier's 1964 Excavations at La Venta, Tabasco, Mexico

By

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Abstract

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Re-analysis of older, scientifically excavated collections using new methods offers a unique opportunity to extend the merits of past archaeological research. This study evaluates the potential for future research of the 1964 La Venta collection excavated by Robert J. Squier and curated by the Biodiversity Institute of the University of Kansas. It focuses on materials from Pit C-1964, one of four units, comprising over 7,500 ceramic and lithic artifacts including obsidian and ground stone. The four principal objectives were: 1) evaluating theoretical characterizations of Olmec culture, including identification the Olmec as the earliest and most influential complex society in Mesoamerica, 2) analyzing different categories of materials to answer specific research questions pertaining to each, 3) addressing the current state of Olmec archaeology and issues associated with collection preservation and management, and 4) making recommendations for future researchers. Methodologies included: 1) sourcing of obsidian artifacts, 2) radiocarbon dating, 3) organic residue analysis, and 4) sourcing of bitumen. This approach has resulted in new information with valuable implications for understanding Olmec culture.

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Chapter 1: Introduction

Robert J. Squier and the significance of the 1964 La Venta Collection

Robert J. Squier's career as an anthropologist, archaeologist, professor, and scholar offered valuable and significant information to the understanding of Olmec culture. Due to his career, his involvement with the excavation and interpretation at the Olmec site of La Venta made it possible for my research to be completed. The 1964 collections excavated by Robert J. Squier offers a unique opportunity to deepen the theoretical and methodological knowledge about La Venta and its early contributions to Olmec archaeology. Along with being a Mesoamerican archaeologist, Squier was a professor and researcher at the University of Kansas from the 1958 to 1989. He was involved in a number of Olmec site excavations with other principal Mesoamericanists such as Philip Drucker (University of California-Berkley), Robert Heizer (University of California-Berkeley), Michael D. Coe (Yale University), and Eduardo Contreras, a long-standing field technician. Their contributions to the study of Olmec archaeology led to the initial definitions of complex society formation in Mesoamerica as well as furthering the Olmec-Centric theoretical position.

There has been little research completed on the 1964 La Venta collection since Squier's original involvement. Since relevant documentation associated with Squier's 1964 investigations were not curated with the archaeological artifacts. These materials could not have been studied or researched critically. In was not until 2015 that all relevant documentation was made available by Squier's estate and transferred to the University of Kansas.

Who were the Olmec?

The Olmec are hypothesized to be a cultural phenomenon that placed the beginnings of complex societies in the New World. Most notably as part of the emergence of one of the six pristine areas of state formation, the Olmec are the earliest complex chiefdom in Mesoamerica. The general divisions of Mesoamerican Pre-Columbian past are split into five distinct periods: the Paleo-Indian, Archaic, Formative (1800 B.C. to A.D. 300), Classic (A.D. 300 to A.D. 900) and Post-classic (A.D. 900 to 1521) (Diehl 2004) (Willey and Phillips 1958). Willey and Phillips (1958) categorize these generalized stages was based upon a series of cross-areal comparisons in a local or regional sequence under stratigraphic control (Willey and Phillips 1958: 57). In the New World, chronological organization is dependent upon the acknowledgment of cultural phenomena which can be compared inter- and intra-culturally. Geographical regions can have distinct chronological sequences dependent upon the observable cultural distinctions and comparable phenomena

The principal area of the Olmec is in the Isthmus of Tehuantepec, which separates the Gulf of Mexico to the north from the Pacific Ocean to the south (Pool 2007). Essentially, the area the Olmec inhabited was situated between future pivotal Mesoamerican cultural centers including the Valley of Mexico to the north and the Maya area, which includes portions of Guatemala, western Honduras, and western El Salvador. The Olmec resided in the northern portion of the Isthmus of Tehuantepec, characterized by three distinct environmental zones: savannah, tropical rainforest, and swamps. The climate of the area is hot, humid, and experiences a large quantity of rainfall each year. The southern Gulf lowlands include the Mexican states of Tabasco and Veracruz. This area is a low-lying coastal plain encompassing four large river systems: the Papaloapan, the Coatazacoalcos, the Tonalá, and the Mezcalapa-

Grijalva (Pool 2007).   A key geographical feature of the area is the Tuxtla mountain range occupying the northwestern potion.

The area known as the “Olmec Heartland” or the “Olmec Metropolitan Zone” (Figure 1) is controversial in name since archaeologists have generalized the area as being represented by only groups associating their affiliations to the Olmec culture while discounting other possible Formative period cultural groups. The name Olmec was derived from the Aztec language Nahuatl. The word, itself, came from the word Olman, which meant “Land of Rubber” and referred to the entire Gulf Coast region as such (Pool 2007: 5).

Figure 1. The Location of La Venta (Google Earth 2016)

The most visible signature of Olmec culture is their massive stone sculptures. These were shaped from immense blocks of basalt cut from quarries in the Tuxtla Mountain region. The sculptures, especially the massive stone heads (Figure 2), represented realistic interpretations of what may have been leaders in the society. The colossal heads are thought to have been distinctive portraits of Olmec rulers (Pool 2007:10). The heads were sculpted from solid pieces of basalt weighing up to 40 tons that would have been transported at least 90 km through swamps and rivers to their final placement in the cultural center (Pool 2007: 10). The representation and ornamentation associated with their leaders was a key characteristic was. It would have obviously taken an impressive amount of manpower to move these blocks of basalt. The terrain was incredibly difficult to traverse as well. Other examples of sculptures express distinct correlations to the cosmological concepts as well as natural forces, which would involve the basis of religious belief.

Olmec society also had a highly complex system of trading prestige goods. There was a high volume of goods imported by Olmec elites, including jade (Figures 3) and serpentine from

Figure 2. La Venta Monument 1

Guatemala as well as iron ore mirrors originating in Chiapas and Oaxaca (Poole 2007). Large quantities of these resources were used for ornamentation and decoration. Specifically at La Venta, large serpentine blocks were arranged in intricate and beautiful mosaics signifying spatial orientation for elite or ritualized use. The need for high prestige items and ritual spaces demonstrates indications of an elite class distinction, which would have depended on these goods to further their social status in the society. Centralized centers of control such as La Venta are inferred from the well-observed examples of monumental architecture, prestige goods, sociopolitical organization, and indications of a cosmological belief system (Poole 2007). Essentially, the population of the Gulf Coast lowlands was located between two major Mesoamerican areas, with the Valley of Mexico to the north and the Maya to the south. The strategic location of the geographic area comprising groups associated with the Olmec culture would have a significant influence on later cultures in all of Mesoamerica throughout the expanse of history.

Figure 3. Figurines from La Venta Offering 4 (Drucker et al. 1959:152-161 and plates 30-36)

Interaction with Olmec Archaeology

I was able to have a first-hand experience of the geography and archaeology significance of the Gulf Coast lowlands in the context of field research in Tabasco, Mexico in January 2016 that was funded by the Tinker Foundation through the Center of Latin American and Caribbean Studies at the University of Kansas. This had a direct effect on my analysis of the 1964 La Venta excavations conducted by Robert J. Squier.

I visited and toured a variety of archaeological sites, museums, and collections, which were classified as being representative of Olmec. I also spent a good portion of my time in Villahermosa collecting resources and publications at the local libraries and research institutions that directly benefited and influenced my understanding of Olmec culture. I visited four different museums, including Sitio de La Venta (managed by the Instituto Nacional de Antropología e Historia, or INAH), the Parque Museo La Venta, the Museo Regional de Antropología Carlos Pellicer Cámara, and the Comalcalco site museum to gain further knowledge of how Olmec culture, and specifically what theoretical positions on the Olmec were being presented to the public. I also obtained valuable resources at the Biblioteca Jose Maria Pino Suarez as well at the research library at the Museo Regional de Antropología Carlos Pellicer Cámara.

I had a chance to fully appreciate the conceptual identities of Olmec and other Mesoamerican cultures as represented in exhibits, displays, and collections. Most notably, the creation of the Parque Museo La Venta in the city of Villahermosa, Tabasco, Mexico by Carlos Pellicer Camera in the 1960s provided the general public with the experience of being able to directly observe complex examples of Olmec craftsmanship in the form of artifacts and monuments from the archaeological site of La Venta.

Carlos Pellicer Camera, a famous Mexican poet, Tabasco native, and amateur archaeologist, first established the Parque Museo La Venta in the late 1950s. Pellicer believed it was his duty to protect the rich cultural heritage for the people of Tabasco. The archaeological site of La Venta was in direct danger of being affected by exploration and extraction of Tabasco's rich supply of natural gas and petroleum in the area. As the result of an effort by Pellicer as well as officials representing Petróleos Mexicanos (PEMEX), all monumental sculptures and relevant artifacts were moved to the Villahermosa in order to protect the cultural heritage. However, efforts to secure the park as a protected area were not achieved until the 1980s. The efforts by Pellicer, PEMEX, and Villahermosa's government officials salvaged important aspects of Tabasco's pre-contact heritage. In accordance with Pellicer's wishes, the layout and construction of the park was to replicate the exact positioning of the monumental forms of sculpture so distinctive of the Olmec culture at La Venta.

Purpose, Objectives and Goals

I attempted to analyze the potential for the 1964 La Venta Collection and its success for future study. Older, curated collections offer just as many researchable questions as newly excavated material especially as methodology and technologies advance. My initial research goal was to obtain viable ceramic sherds for ceramic residue and radiocarbon analysis, however, due to limited time and funding, this project was not feasible. After reviewing the materials in the collection, I chose to focus my attention on one (Pit C) of the four pits excavated during the course of the 1964 excavations at La Venta. To clarify, Squier named his excavation units with the label "pit" and are in no way similar to the excavation procedure described by the current understanding of the terminology associated with "pit". After analyzing the material in Pit C, I came to the conclusion that the Squier collection held many opportunities for research utilizing a current theoretical understanding and technological procedures.

The significance represented by a relatively inactive and unknown collection could be an important addition to all knowledge in regards to the interpretation of La Venta as well as Olmec culture. Older collections are incredibly valuable because of unanswered questions. I have attempted to evaluate four principal objectives: 1) evaluating theoretical characterizations of Olmec culture, including identifying the Olmec as the earliest and most influential complex society in Mesoamerica, 2) analyzing different categories of materials to answer specific research questions pertaining to each, 3) addressing the current state of Olmec archaeology and issues associated with collection preservation and management, and 4) making recommendations for future researchers.

My first objective has been to describe current theories on the Olmec culture and to describe how these have fluctuated over time with specific focus on how interregional trade in the "Olmec heartland" was an integral aspect of sociopolitical in Mesoamerica. High valued resources such as obsidian and jade were acquired from long distances away from many of the Olmec centers. Gaining a better understanding of the interpretations of Olmecs and their relations towards groups outside of the Olmec heartland is crucial for the interpretation of Olmec culture. The 1964 Squier collection contains a sizable collection of obsidian artifacts. These artifacts were traded over long distances and were valued highly due to their utilitarian and spiritual significance. Theoretical discussions supported by the artifacts examined in the 1964 Squier collection could offer insight into the higher level theoretical concepts associated with Olmec culture.

My second objective is to utilize the material collected during Squier's 1964 excavations at La Venta to undertake some limited pilot testing of hypotheses and to propose testable research questions that can help guide future study of these materials. I have undertaken radiocarbon dating, organic residue analysis, and obsidian sourcing. The first portion of my research has been oriented directly towards the organization and creation of an inventory for Pit

C based on artifact types, their distinctive attributes, catalogue numbering, measurements and weights, and an attempt to refit broken ceramic sherds. According to Sullivan and Childs, "curation is a process that begins in the field and continues in the repository" (Sullivan and Childs 2003: 1). I have instilled this philosophy in my approach to the collection because its potential for research is so significant. The full inventory will be available for use by the KU Archaeological Research Center (ARC) as well as any other research institutes.

My third objective is to address the current state of Olmec archaeology and issues associated with collection preservation and management. Methodologies associated to the care, management, and organization of archaeological material has drastically changed in the last 50 years. For example, I found delicate obsidian blades being housed with hundreds of ceramic sherds and rock fragments. In order to protect and ensure that the archaeological material is kept in tact for future research, updating curation standards needs to be of high priority. In analyzing the collection, I needed to be actively accessing curation protocols as well as accessing the limitations for research. Missing material or documentation needed to be accessed as to determine the scientific value ascribed to the current state of the collection.

My fourth objective is to discuss the current state of Olmec archaeology with reference to the preservation and utilization of archaeological sites and collections for future research. There are new possibilities to test and re-test past methodologies and techniques using older collections, specifically four different avenues of potential research: 1) obsidian sourcing, 2) re-analysis of datable material, 3) ceramic residue analysis, and 4) bitumen source analysis. For my analysis, I will be running the source identification analysis for the obsidian found in the collection while purposing the need for future research to be conducted on the remaining hypothetical research topics. By introducing new scientific analysis, archaeologists will be able to ask questions different from those the original research was intended to answer.

Through the utilization of X-Ray Fluorescence (XRF), key distinguishable artifacts can be chemically linked to their original areas of material procurement. In total, 72 samples of obsidian ranging from complete blades, fragmented blades, decorations, wedges, obsidian shatter, and flakes with recognizable retouch were collected from Pit C. However, there are three more excavation pits, which comprise of the entire collection. The flakes were systematically excavated in levels associated with Middle to Late Formative occupations. These have established a key starting point for research on the obsidian artifacts in the collection. There has been considerable research completed on obsidian from Olmec sites. However, these have been undertaken on materials from other Olmec centers, including San Lorenzo Tenochtitlan and Tres Zapotes rather than La Venta. The results obtained from samples tested by the Archaeometry Laboratory at the University of Missouri Research Reactor (MURR) will be especially significant for establishing known sources of obsidian in the temporally and spatially distinct center of La Venta. La Venta appears to have functioned as an area of commerce, trade, religious expression, and social growth. By establishing a geographical relationship between the obsidian excavated from La Venta and other principal centers in the Olmec heartland, more evidence can be used to infer questions associated with highly complex trading networks, analysis of use and function, as well as its association with domestic versus ceremonial practice.

I hope this project will assist others in further research on the collection. La Venta's prominence and role in Mesoamerican archaeology is immense. Many well-known and distinguished archaeologists have worked in the Olmec discipline of archaeology. I am grateful for the opportunity as well as the chance to make a contribution to the practice Olmec archaeology and our understanding of Olmec culture.

Chapter 2: Historical Background of La Venta 1964 Excavation

La Venta has been identified as the principal center of Olmec culture during the Middle Formative period. Coe established a model describing:

> … two great periods of cultural successions in the Olmec civilization of the heartland. The first is associated with the San Lorenzo phase, dated by radiocarbon to about 1200-900 BC; the second would correspond to the height of La Venta, about 900-400 BC (Coe 1989: 69).

This model is highly contested by archaeologists in on the basis of radiocarbon evidence as well as theoretical interpretations of Olmec "style". This chapter will focus on background information about the site of La Venta and the correlations through alternative studies supporting themes accounting for discussion of La Venta chronologies. The current theories regarding La Venta's chronology is primarily based upon two methodological interpretations: ceramic typologies and radiocarbon dating. A clear understanding of La Venta's chronology is still being discussed and argued. The 1964 La Venta collection can help establish a better understanding of the complex chronology at La Venta.

The Archaeological Site of La Venta

Matthew W. Stirling undertook the first excavations in the region in 1941. He observed and excavated the large basalt sculptures, which were originally located all over La Venta. Philip Drucker arrived at the site in 1943 to collect ceramic samples for developing a ceramic sequence for the region (Drucker et al. 1959: 1). It was not until 1955 that extensive excavations by Philip Drucker, Robert Heizer, and Robert Squier attempted to reconstruct the methods of the architecture and construction of the large monumental structures. The 1955 excavations involved the most thorough and comprehensive study of the site and were able to document a large variety of culture change in architecture, social hierarchy, cosmology, and artistic expression.

At its height, La Venta would have spanned over 200 hectares with most architecture created for elites. As seen in Figure 4, a variety of earthen mounds and courtyards are systematically oriented along centerline eight degrees west of modern magnetic north (Diehl 2004: 61). The city is hypothesized to be a "Regal-Ritual City" where ritual and ideology determine how society should function (Diehl 2004, 61). The city includes formal entrances, royal compounds, and religious structures, as well numerous large, basalt sculptures. The city was specifically meant for the elite class while lower classes would reside towards the outskirts of La Venta.

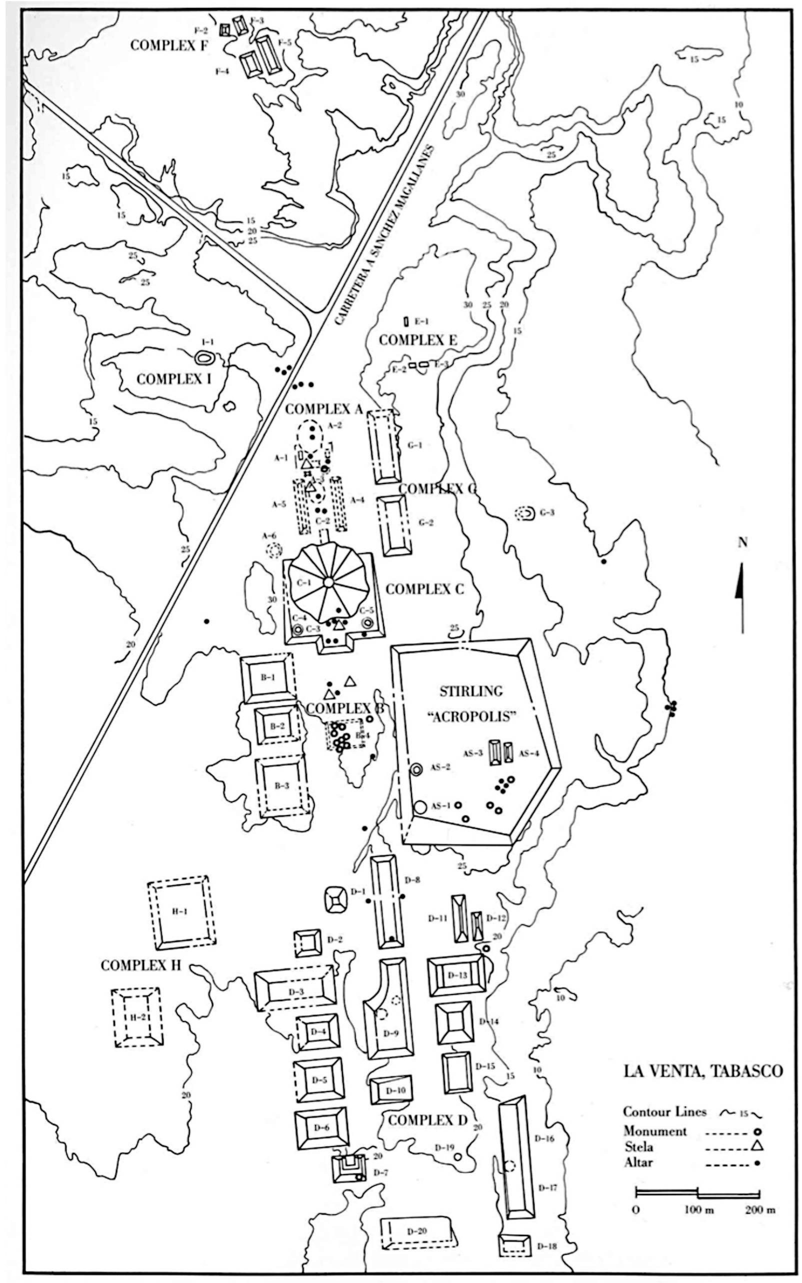

Figure 4. Archaeological Plan of La Venta (Lauck 1988: 74)

The ultimate demise of La Venta occurred around 400 BC (Diehl 2004: 81) and is thought to have happened in the form of a rapid collapse. Little is known why this center collapsed, but more evidence points to the overexploitation of natural resources around large ceremonial centers (Diehl 2004: 81). Evidence from geophysical studies (Jiménez 1990; Ortiz Perez, Arturo, and Cyphers 1997; and Cyphers 1981) indicates the possibility of a shift in climate could have initiated a time of extreme drought or other factors, which may have been influenced by the close proximity to the volcanoes of the Tuxtla region. Heavy ash falls and ash sedimentation would have clogged river systems as well as making agriculture incredibly difficult. Human responses to these catastrophic events could have lead to the demise of the Olmec culture (Diehl 2004). Political unrest or economic depravity could have been direct responses to the natural events taking place. The combination of natural phenomena and the human response would have ultimately led to the unraveling of the political influence and control of the highly valued resources in the area (Diehl 2004).

Excavation History at La Venta

In 1925, Franz Blom and Oliver La Farge of Tulane University were the first Westerners to identify and document archaeological remains at La Venta (1926). With the aid of local guides, Blom and La Farge documented eight major stone monuments, including a colossal head, altars, and stelae (Grove 1997: 56). Blom and La Farge would later mistakenly attribute their findings to Maya groups. Although wrong, Blom and La Farge began the research at a principal center in the Olmec heartland.

The first systematically driven archaeological research of the Olmec began in 1938 under Matthew Stirling of the Smithsonian Institution at Tres Zapotes (Grove 1997: 56). Philip

Drucker joined Stirling at Tres Zapotes in the second field season of work (1939-1940) and began a partnership that would later excavate, analyze, and publish a large amount of information on La Venta in the next few decades. Much of their work in the 1940s and early 1950s was dedicated to gaining a better understanding of La Venta's sequence of occupation through the excavation of Complex A, the northern sector of the ceremonial center. The primary excavation methodology was the use of trenching to explore the stratigraphic sequence in the principal mounds of Complex A. For example, a bisecting trench was utilized on Mound A-2 of Complex A. The excavators recorded a rich assortment of artifacts and features, including a sandstone coffer filled with greenstone objects that appeared to have been oriented as if an individual had been placed in it (Grove 1997: 59). As they continued to excavate Mound A-2, the archaeologists found a basalt tomb constructed of 38 naturally occurring basalt columns. It contained ceramic figurines, ear spools and "perforators" (Drucker 1952a). The early 1940s excavations yielded an impressive amount of highly stylized goods, including stone monumental art, possible tombs, serpentine mosaic pavements, and over 370 greenstone celts (Drucker et al. 1959). A ceramic typology presented by Drucker's research report (1952) is still the primary source of data associating stratigraphic associations with ceramic types (Grove 1997: 58).

Much of the work on Olmec culture from the 1950s was undertaken in the context of Heizer, Drucker, and Squier's 1955 excavations. Drucker had been frustrated with the quality of information produced by Stirling's earlier excavations and wanted to return to Complex A at La Venta to clarify the site's stratigraphy (Grove 1997: 62). The 1955 fieldwork provided the first radiocarbon dates of the site and ended the speculation concerning the dates of its creation and occupation. The dates ranged from 3110 B.P. ± 300 to 2130 B.P. ± 300 (Drucker et al. 1959), representing what was thought to be a conclusive occupation range for the entire site. However, many believe that there needed to be more conclusive evidence documenting clear stratigraphic associations of the *in situ* charcoal samples to support the chronologies associated with occupation at the site. Furthermore, the dates were obtained during the infancy of radiocarbon dating itself, at a time when the initial methods were still being developed and tested. Unfortunately, with the discovery of petroleum in the area encompassing La Venta, PEMEX began its operations there in the mid-1940s and greatly expanded them in the 1950s. The construction of an airfield destroyed a large proportion of the site, including destroying parts of Complex A (Drucker et al. 1959). The preservation and protection of the large stone monuments, altars, and stelae was of great concern at that time. A monumental effort undertaken by PEMEX officials, Villahermosa government officials, and Carlos Pellicer Camera sought to transport all movable artifacts to a secondary location in the city of Villahermosa, over 100 km from the archaeological site (Grove 1997: 62). The destruction of the site continued until the 1990s with the construction of PEMEX facilities, a small modern settlement, a pipeline, and large petrochemical complex (Grove 1997: 62).

In the 1980s, an effort by the Instituto Nacional de Antropología e Historía (INAH), the State of Tabasco, and archaeologist Rebecca González Lauck successfully instituted a program to protect, restore, and research La Venta (Grove 1997: 69). González's (1988) research objectives included ascertaining the extant of the site area through survey, clarifying ceramic and architectural sequences, conducting a magnetometer survey to find buried stone features, analyzing lithic artifacts, and finally constructing a foundation based upon systematic contexts with which to interpret cultural patterns and activities (Grove 1997: 69). The efforts made by González and others directly protected La Venta for future excavation and analysis.

Relevant Chronologies

The specific periods of occupation and architectural construction at La Venta remain contested and inconclusive. Due to the destructive effects of PEMEX activities upon the site in the late 20th century, the chronological sequence at La Venta needs to be critically reanalyzed in order to identify intact or previously excavated contexts from disturbed ones. During his 1964 excavations, Squier based his research on assumptions about chronological sequences that had been previously created by earlier investigations at La Venta. For example, Drucker, Heizer and Stirling had completed a large amount of research to describe the construction phases of Complex A. Heizer (1964) defined four phases for construction and subsequent activities at Complex A. These phases, designated as La Venta I-IV, are divided equally in 100-year segments across a 400-year timespan from 2750-2350 B.P. (Heizer 1964). However, variations in the radiocarbon dates do not correspond with contexts associated with the different phases (Grove 1997: 72). In an attempt to address these uncertainties, there have been various efforts to identify sequences at other Olmec sites that may correspond to that of La Venta.

Coe and Diehl produced what is considered to be a reliable chronological sequence at San Lorenzo that has become a standard of Formative Period archaeology. However, the full chronological sequence at San Lorenzo, which ranges from 3500 B.P. to 2100 B.P., may pre-date the initial occupations at La Venta. Evidence offered for pre-2750 B.P. occupation periods at La Venta has not been properly correlated with the site's stratigraphy. As seen in Figure 5, the chronological sequences of San Lorenzo and La Venta have been compiled to offer a better understanding of the complex chronological histories. William Rust and Barbara Leyden (1994) made an effort to create a basic chronological sequence based largely on hinterland sites near the outer perimeter of the ceremonial core of La Venta. Their sequence includes a series of seven phases (Rust and Leyden 1994):

Early Bari	4200-3700 B.P.
Middle Bari	3700-3350 B.P.
Late Bari	3350-3100 B.P.
Early La Venta	3100-2750 B.P.
Late La Venta	2550-2450 B.P.
Early San Miguel	2450-2150 B.P.
Late San Miguel	2150-1850 B.P.

These periods are based upon uncorrected radiocarbon samples pertaining to archaeological contexts, which have not been published, or artifacts correlating to said phases have not been illustrated (Grove 1997). However, issues pertaining to contextual integrity plague La Venta research due to the overwhelmingly complex stratigraphic context, ceramic typology, and destructive actions caused by PEMEX.

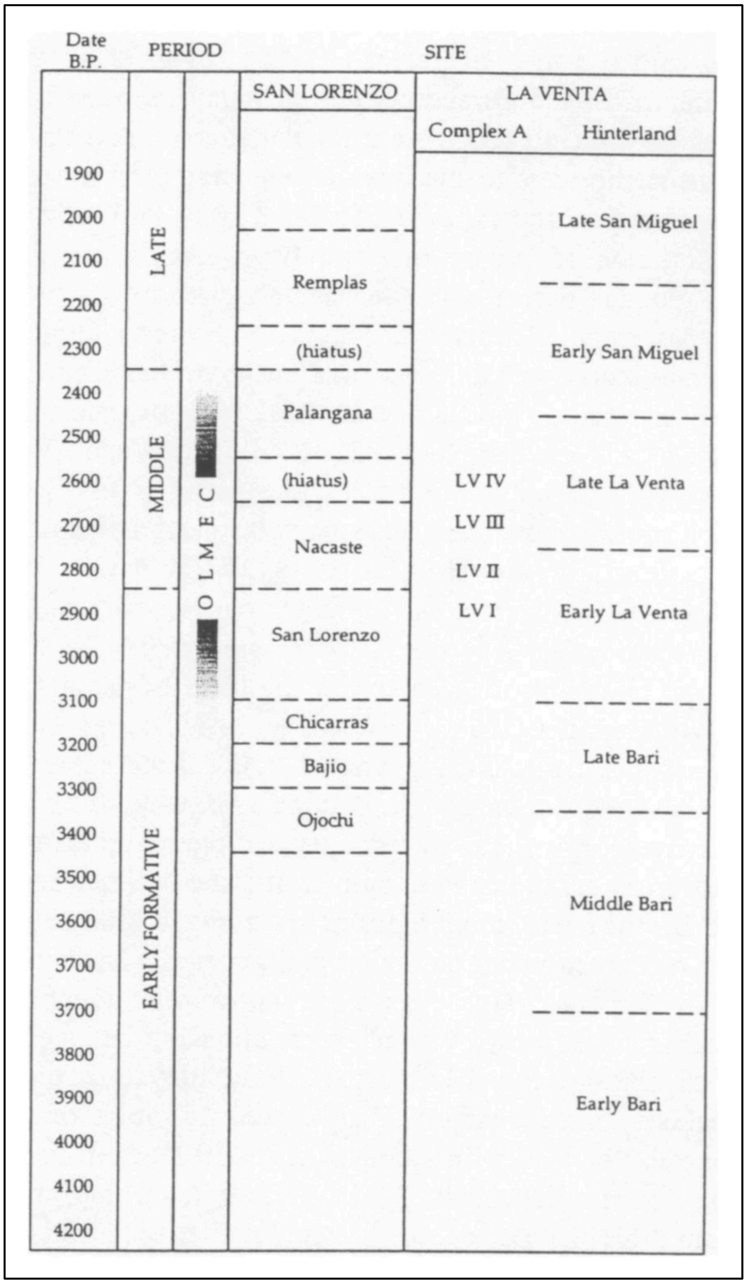

Figure 5. Chronologies of La Venta and San Lorenzo (Grove 1997:54)

In 2008, Rust's dissertation entitled "A Settlement Survey of La Venta, Tabasco, Mexico" offered the most comprehensive and up-to-date understanding of the chronological sequence and pottery typology ascribed to the site of La Venta. The primary goals of his research were to:

> 1) sample portions of the La Venta site core, adjacent to the ceremonial zone, and to look for settlement features there; 2) survey the surrounding riverine periphery zone, in order to find evidence of local site contemporary with, or earlier than, La Venta; 3) establish a typology of La Venta pottery using the type-variety method, and base the dating of the pottery sequence, as much as possible, upon radiocarbon dates; 4) establish a baseline of data on settlement features and subsistence from both La Venta and surrounding sites; 5) correlate this settlement data with evidence of settlement hierarchy (Rust 2008: 176).

Much of Rust's attention was focused on surveying the periphery of the Río Barí and locating specific settlement sites that would have been inhabited by those of lower status than those living in the ceremonial core of La Venta. He chose the Río Barí due to the likelihood of settlements that would have been directly influenced by elite control from La Venta. Other surveys focused on the residential and domestic household complexes (Complexes E, G, and H), the periphery of La Venta, daily domestic activities, ceramic production, and obtaining evidence with which to construct an improved chronological sequence. The Río Barí sites offered a context with which to infer specific relationships among settlements. Specifically, they provided subsistence remains and charred plant material for radiocarbon dating, ceramics, and lithic remains representing subsistence activities and providing a clearer picture of conditions prior to, during, and after La Venta's height of political power and influence (Rust 2008: 1398). The most significant aspect of the research from the Río Barí sites was the refinement of a chronological sequence supported through stratigraphic excavations and based on new dates from charred material that could be used in association with ceramic types to create a ceramic typology, and local chronological sequence directly related to the principal center.

The work completed by Rust changed the entire perception of La Venta settlement chronology. Through the analysis of the three residential and household domestic contexts (Complexes E, G, H) (200-500 meters away from the primary ceremonial center around

Complex C) as well as the survey completed in the riverine periphery of La Venta, a clearer indication of the subsistence and other activities, chronology, and a direct relation to the ceremonial center of La Venta was developed (Rust 2008: 1398). Specifically, the riverine periphery offered a better understanding of social relationships accounting for the differentiation of status represented through the actual artifacts. Rust's analysis of pottery, figurines, and lithics indicated a direct correlation to the separation of activities associated with domestic and ritual contexts. These interpretations and correlations could have direct implications for the analysis of the 1964 La Venta collections. By using comparable studies from domestic settings along the periphery, a better understanding of the complex ceramic and lithic assemblages excavated from in the ceremonial center can have significant implications for the interpretation of chronology at La Venta. Through the use of similar strategies, the 1964 La Venta collection represents a significant aspect of La Venta research, which has been hitherto unknown. The time and effort needed for the complete analysis of the entire 1964 collection could drastically support a better understanding of La Venta knowledge and ultimately, the Olmec culture.

General Purpose for Excavation

The collection made at La Venta by Squier has received relatively little research attention for the past 50 years, during which Squier devoted a great deal of time to administration of KU's Department of Anthropology. The 1964 excavation focused on three goals that were intended to act in part as a rebuttal to a critical review by William Coe and Robert Stuckenrath of previous excavations at La Venta (Coe and Stuckenrath 1964). The goals of the excavations were to: 1) achieve a better understanding of the temporal range at the site in regards to occupation, habitation, and abandonment; 2) acquire charcoal samples in direct association with certain ceramic types specified by 1955 excavations at La Venta; and 3) interpret the size of the habitation zone for population estimates (ARC, RJS Collection, Field Notes, 2015). Specifically, Coe and Stuckenrath questioned the date assigned to A-2, the principal mound at the site. The debate between Squier and Coe and Stuckenrath was related to the Mother Culture Model. Coe and Stuckenrath supported the *primus inter pares* position while Squier was concerned with the *Olmec-centric* position. Coe and Stuckenrath interpreted the chronologies associated to the early construction phases of La Venta, specifically Complex A, as having varied contextual support. These were the principal means that Squier attempted to clarify in the context of La Venta. Squier would focus his attentions on finding relatively undisturbed contexts with charcoal remains in order to establish significant evidence supporting the prior theories regarding La Venta occupation.

In total, Squier supervised the excavation of four trenches ranging in size and depth in June and July of 1964. The excavations were a series of four test pits: Pit A-1964, Pit B-1964, Pit B1-1964, and Pit C-1964 seen in Figure 6. Squier noted that Pit A-1964 was located on the western portion of Complex A about eight feet from the western portion of the mound structure. The excavation unit measured two meters by two meters and was systematically excavated in three levels of fifteen-centimeter increments. Excavation was ceased after three levels due to Squier's assessment of the chronological validity and the probable contextual disturbance supported by the archaeological material found. Pit B-1964 was located on the east by southeast edge of La Venta Island. The excavation unit was one meter by two meters excavated in fifteen-centimeter increments. In total, thirteen levels were excavated from this unit and the context was concluded to be undisturbed by Squier. Pit B-1 was a one-meter by one-meter unit added onto Pit B-1964. Excavation proceeded in fifteen level increments with a total of fourteen levels excavated. Pit C-1964 was located on south of the southwest corner of Complex C, approximately 200 yards. Squier excavated a one-meter by two-meter trench in fifteen-centimeter increments for twenty-three levels. The amount of time and effort extended toward the excavation of each Pit was dependent on the context of the Pit. If the pit exhibited an undisturbed primary context, Squier continued further excavation. The exact locations of each of the pits are unknown, but from Squier's original notes, I was able to locate general areas based upon the available information provided. Unfortunately, there were no maps included in the donation of the collection, which related to the 1964 La Venta excavations.

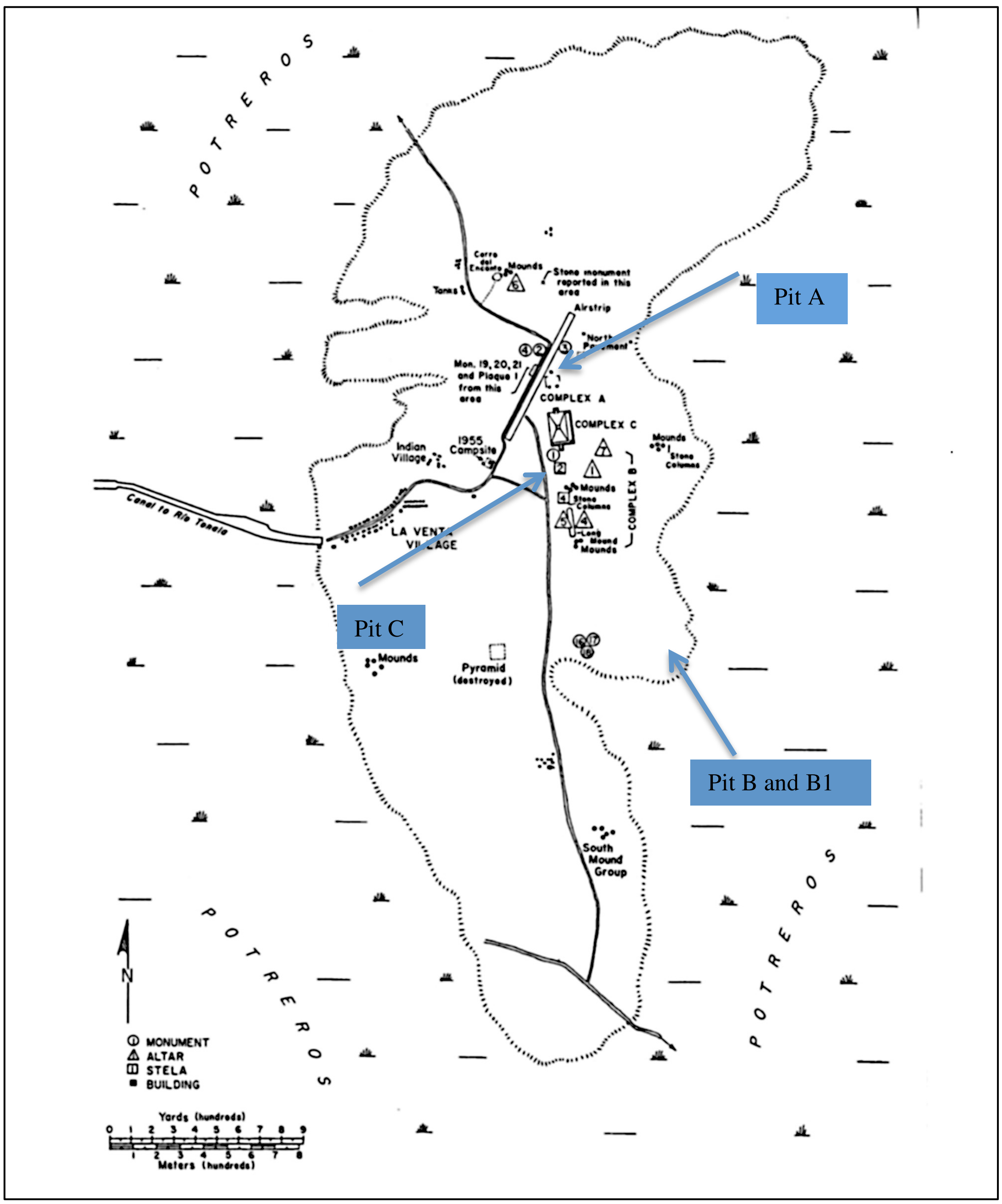

Figure 6. Generalized Excavation Locations (after Drucker et al. 1959: Figure

The most comprehensive location offered of the four excavation pits was given for Pit C. Squier indicated that Pit C was formerly located in a habitation area approximately 200 yards south of the southwestern corner of the La Venta pyramid (Complex C) (ARC, RJS Collection, Field Notes, 2015). In each of the test pits, stratigraphic data were associated with ceramics that varied in age. Squier did not utilize the prescribed chronological period classifications described by Drucker (1952), but classified sub-phases (i.e. Early Formative a, b, c) (Figure 7) based upon ceramic type differentiation used to develop the Mesoamerican chronological sequence (ARC, RJS Collection, Field Notes, 2015). Pit C-1964 offered the most continuous representation of ceramic types relevant to each of the defined temporal periods (Early, Middle and Late Formative). However, it was missing certain sub-phase ceramic types from the Early and Middle Formative periods. Other pits provided samples relevant to the chronological gaps in Pit C-1964. In total, four charcoal samples labeled 788 A through D was acquired from levels in Pit C-1964. The uncalibrated radiocarbon samples included: 788A- Insufficient Sample; 788B- 2650 ± 240 B.P. (700 B.C.); 788C: 3760 ± 80 B.P. (1810 B.C.); 788D: 9750 ± 160 B.P. (7800 B.C.). The charcoal samples are problematic since they were acquired from the soil matrices that did not have prominent charcoal-bearing features such as a hearth. Squier described the charcoal as being small, sporadic pieces found in association to cultural materials. However, Squier believed the probability of re-deposition of charcoal remains was minimal due to no apparent disturbance of ceramics types from their probably primary contexts (ARC, RJS Collection, Field Notes, 2015). The dates acquired from these charcoal samples correlate well with the supposed dates of the associated cultural materials.

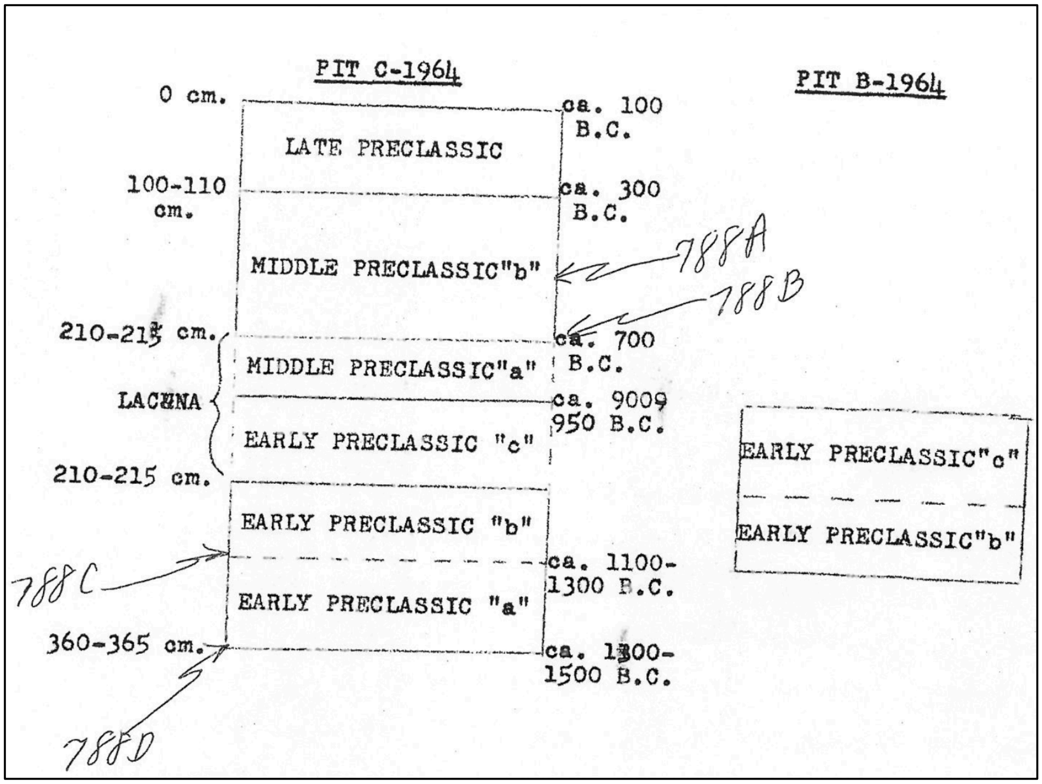

Figure 7: Stratigraphic profile in association to charcoal samples (ARC, RJS Collection, Field Notes, 2015)

Román Piña Chan and Roberto Gallegos excavated Pit C by in 1958. Their 1964 book, *El Pueblo del Jaguar (Los olmecas arqueológicos)*, provides little detail about the excavation location or stratigraphic profiles. Piña Chan and Gallegos claim to have found material pre-dating the construction of Complex A (Piña Chan and Covarrubias 1964). In an effort to re-analyze the location described by Piña Chan and Gallegos in the 1958 excavations, Squier attempted to relocate the 1958. A general location was documented by Squier in his field notes near the southwestern corner of the main La Venta pyramid (Complex C) about 100 yards from the described corner at a bearing of 270° (ARC, RJS Collection, Field Notes, 2015). In an attempt to relocate and contest Piña Chan and Gallegos's initial claims, Squier enlists the help of Don Fermín Torres, a member of the original excavation crew of Piña Chan's excavations, to help in the process of locating the exact area of prior excavation. Evidence of Piña Chan's back dirt and excavation trench were apparent when locating the site. Robert Heizer, Philip Drucker, and John Graham (1967) observe evidence of prior excavation as well when examining the western portion of Complex C (a possible connection to either Squier's or Piña Chan's work) and indicate that:

> Since 1955 there has been a considerable amount of excavation (apparently "scientific" rather than by treasure-hunters) on the platform at the south edge of the pyramid. The unfilled trenches, some scattered sherds, and helter-skelter array of large, flattened slabs of Chinameca limestone show that whoever did the digging must have found something, and that his technique leaves much to be desired. No published report on this extensive excavation is known to us, and we did not learn from local people when and by whom the work was carried out (Heizer et al. 1967: 11-12).

Although pure speculation, Heizer could be alluding to either the prior excavations of Piña Chan or Squier since both of their excavations were never officially published or reported.

The total amount of cultural material from Squier's 1964 excavation exceeds over 10,000 artifacts comprising ceramic sherds, figurine fragments, charcoal samples, lithic artifacts, and geological samples. Squier focused much of his attention on the ceramic classifications associated with the excavations, distinguishing specific ceramic attributes that would then correlate to a specific group classified by Drucker in early excavations at La Venta. In the comparison of ceramic attributes, wares are defined on the basis of different pastes, tempering techniques, and relative durability of the ceramic artifact (Rust 2008). The combination of ware attributes is compiled into a ceramic group (Rust 2008). A ceramic variety is formulated on the basis of a ceramic group, usually defined on the basis of surface treatments such as incised designs, painting, brushing techniques, punctuation, or rocker stamping (Rust 2008). In La Venta ceramic classification, there are ceramic groups, which are defined once the attributes of ware and the vessel color have been distinguished. Squier sought to associate particular ceramic groups with specific excavated levels. However, he appears to have had difficulty comprehending the complexity of Drucker's ceramic classification system, an incredibly detailed description of all ceramic wares, vessel forms, and notable decorations in La Venta ceramics. Drucker's classification focused upon a series of different wares corresponding to utilitarian and ritual uses. These included Coarse Buff, Coarse Black, White-Rimmed, Coarse Brown, Coarse White, Coarse Red, Brown Lacquer, Fine Paste, La Venta Fine Paste, and Painted wares (Drucker 1952).

Findings and Conclusions

After careful yet complicated excavations, Squier believed he had successfully accomplished the intended goals for the excavation including the collection of key charcoal samples from known contexts that would be used for conventional radiocarbon dating. He recovered a total of four charcoal samples from the June-July excavations at Pit C in La Venta. The charcoal samples were correlated with ceramics that corresponded to sequences identified in previous studies. Of the four samples, one did not represent a significant sample size for radiocarbon dating methods of the time, so its date was not possible to determine. However, the remaining three dates were interpreted as being consistent with their stratigraphic contexts. According to Squier, the charcoal samples could not be associated with specific features or activities. There were no occurrences of definite charcoal-producing features such as hearths, ovens or kilns. The charcoal was picked from small-scattered pieces in the soil matrices. Since there was no evidence of a charcoal-bearing feature, there is the possibility that the charcoal was re-deposited from older charcoal-bearing soils before its documented context. However, there was no such evidence documented during excavation of redistribution in regards to the cultural materials.

The cultural materials documented in Pit C were described according to their stratigraphic position and chronological phase classification. In Pit C, cultural materials were found to be representative of Early Formative, Middle Formative (La Venta Phases), and Late Formative. After the completion of a ceramic analysis conducted by Squier, he concluded that the Early Formative period included White Ware, Black Ware (not common), Mottled Black, White- Rim, Fine Paste Gray, "Fired" White, Fine Paste Orange. The Middle Formative Period (La Venta Phases) demonstrated a high jump in frequency of Fine Paste wares including Fine Paste Cream, Fine Paste Red, Fine Paste Orange, White Course, White Rim, and Black Course. Late Formative demonstrated a drop off in total frequencies of all previously mentioned wares (ARC, RJS Collection, Field Notes, 2015). The stratigraphic sequence appeared to be undisturbed, however, later subphases of Early Formative and earlier subphases of Middle Formative appear to be missing from the stratigraphic sequence. Evidence for the missing subphases was documented at Pit B of the 1964 La Venta excavation. The combination of the full stratigraphic sequence represented in both pits as well as the support gained by the radiocarbon results infers the validity that the context at Pit C was undisturbed. The missing subphases could have been the result of different occupation locations at different periods of La Venta's occupation.

Chapter 3: Theory

The role of interregional trade in the Olmec heartland was an integral aspect of defining its sociopolitical position in Mesoamerica. Specifically, high valued resources such as obsidian and jade would be acquired from long distances away from many of the Olmec centers. Gaining a better understanding of the theoretical interpretations defining the Olmec and their relations towards groups outside of the Olmec heartland is crucial for the interpretation of Olmec culture. Theoretical interpretations of La Venta have suggested its importance as an active trading center of a number of highly valued goods. The obsidian in the 1964 La Venta collections offers the unique ability to gain a better understanding of the complex social relations, which would have been characterized through relations propagated by the elite. In this section, I will be discussing the theoretical history pertaining to the Olmec as well as specifying the networks of exchange (obsidian and jadeite) and its affect on the sociopolitical organization of the Olmec culture.

The Olmec Problem and Sociopolitical Organization

The beginnings of the Formative Period in the New World were characterized by a distinct change in social complexity as a result of cultural evolution. The transition from the Archaic stage happened as a result of the ability of populations to secure sustainable forms of subsistence through the development of agriculture as well as their ability to manage sedentary village life (Willey 1958). With populations becoming more sedentary through the dependence on agricultural systems, Formative period populations would come to develop a new set of culturally distinct systems including “pottery-making, weaving, stone-carving, and a specialized ceremonial architecture” (Willey 1958: 146) that would separate culturally unique patterns of production strategies. These developments would become gradually more distinct and complex as time and regional influence expanded beyond the central development of the society. Specifically, with the influx of research conducted on Classic period sites and cultures of Mesoamerica, the processes that developed into the complexities of those great societies needed to be understood. Robert J. Sharer (1989) notes how the interest in Formative-era societies followed from knowledge obtained through archaeological research on state-level societies of the Classic Period. There was a need for more research to be conducted on the Formative era in order to investigate the complex processes observed in the later periods. Ironically, there is relatively more knowledge pertaining to the development of complex societies in the Formative era on regions outside the Gulf Coast than on the cultures represented in the Gulf Coast. These regions have evidence for a crucial time during which there was the "the emergence of a relatively small but powerful elite segment of society that dominated the economic, political, and religious institutions, and thereby held sway over a numerically larger non-elite population" (Sharer 1989: 4). Archaeologists have identified a distinct set of cultural patterns accounting for the change in societal development. Archaeological investigations included documenting differences among residential structures and others that were more elaborate and for non-residential use; the creation and modification of public buildings functioning for civic or ceremonial purposes; changes in society as reflected in an individual's status in mortuary contexts with associated goods; and the presence of artifacts of local manufacture compared to exotic imports (Sharer 1989). These signify a distinct change in social complexity and characterize a shift in kinds of Formative societies.

The shift into the Formative era in Mesoamerica has been defined in part by changes in social complexity that accompanied a transition from mobile hunter-gatherers to sedentary village agriculturalists. One of the most highly discussed cultures in Formative era Mesoamerica is the Olmec. Michael Coe asserts that the Olmec social structure was dependent on the "elite center" (1962). Elite centers are

> … clusters of architectural and monumental art and religious works, and residences of ruling and priestly hierarchies, whereas the mass of the people, the swidden agriculturalists, lived in scattered villages and hamlets (Fried 1975: 177).

According to Coe, the elite centers would give rise to the highly distinctive art forms recognizable as Olmec. Coe classifies the unique art pertaining to an Olmec "style" which "emphasized human infants with snarling, jaguar-like features" (Coe and Koontz 2008). This distinctive iconography also includes

> "life-size, or greater than life-size, full-round, and bas-relief stone monuments. These include free-standing heads, human and anthropomorphic figures, stelae, and alters….Olmec sculptures also occur as small pieces: jade and serpentine figurines, celts, ornamental effigy axes, plaques, and other small ornaments" (Willey 1962: 2).

With the emergence of the identification of a distinctive art style, Coe concludes that the Olmec represented a great civilization that distributed their iconic art style throughout the Gulf lowlands and geographic regions surrounding Olmec heartland (Coe and Koontz 2008; Willey 1962).

There has been much theoretical discussion in regards to what many authors identify as the "Olmec civilization". Morton Fried ascribes semantic issues to the meaning and context of what is typically classified as a civilization (1975). In Kroeber and Kluckhohn's book, *Culture: Critical Review of Concepts and Definitions*, the concept of civilization is conditioned by colonial influence. The semantics would change depending on the European country using the concept (Kroeber and Kluckhon 1952). Specifically, in English, civilization "was associated with the notion of the task of civilizing others" while Germans associate the meaning in "relation to the state… to spread political development to other peoples" (Kroeber and Kluckholm 1952: 11). Mesoamerican archaeologists recognize distinctive qualities associated with the appearance of a civilization. As indicated by V. Gordon Childe (1950), these indicators include a refined art style, specialized architecture, calendar, and writing system (Fried 1975). These indicators are not definitive because varied ethnographic and archaeologically contexts provide many exceptions. When definitions and classifications made with them are not clear, archaeologists have an extremely difficult time characterizing sociopolitical organization. Classification of sociopolitical organization becomes even more difficult given the range of social complexity of Formative era societies. As indicated before, Coe designates the Olmec as a "civilization" based solely on his recognition of an art style that designates a core belief system representing a form of religion (Coe and Koontz 2008) However, other interpretations of sociopolitical organization would classify the Olmec as an empire, theocracy, state, or chiefdom (Diehl 1989). However, the current theories and archaeological evidence classify the Olmec culture as consisting of a large contingent of chiefdoms. The foundation of the chiefdom model comes from the general agreement that

> Olmec societies were non-egalitarian and that some individuals enjoyed higher status than others. The evidence for this includes the large construction projects, monumental carvings, and other indicators of organized labor management; and the presence of rare-high status goods in burials and other contexts (Diehl 1989).

The shift in archaeological method and theory in the 1960s at gatherings such as the Dumbarton Oaks Conference on the Olmec (Benson 1968) contributed to discussions about how scholars should define sociopolitical organization. The conference included papers and discussions by the leading specialists in Mesoamerican archaeology including Matthew W. Stirling, Robert F. Heizer, Michael D. Coe, Kent V. Flannery, Tatiana Proskouriakoff, Ignacio Bernal, Peter T. Furst, Robert J. Squier and David C. Grove. Of these, Michael Coe and Kent V. Flannery addressed the issue of sociopolitical organization using varying terminologies.

Classifying Chiefdoms

Identifying a chiefdom from archaeological data is difficult. Archaeologists often enlist the help of ethnographic accounts to correlate patterns of known sociopolitical organization with those represented in the archaeological record. Kent Flannery (1972: 402) suggests a chiefdom represents "the leap to a stage where lineages are 'ranked' with regard to each other, and men from birth are of 'chiefly' or 'commoner' descent, regardless of their own individual capabilities". In other words, an individual's status was ascribed, rather than achieved. The chief holds a variety of roles including those pertaining to religious, political, and economic decision-making and activities. This definition identifies the most significant aspect in the jump of chiefdoms from simpler societies: the introduction of rank and ascribed status (Fried 1967). The basis for determining ascribed vs. achieved status through archaeological contexts is heavily influenced by interpretation of infant or child burials (Flannery 1972). Burials that exhibit a rich assemblage of grave goods accounting for an affiliated status could indicate a "ranked" status. At La Venta, there are three examples of the possible burial treatment of high-ranking individuals including a stone column tomb, a sandstone coffer/sarcophagus, and a sandstone cist/probable tomb near the base of Mound A-2 (Drucker 1952). However, these interpretations about sociopolitical organization can only be perpetuated if there are both elite and domestic burial contexts. The occurrence of chiefdoms is heavily dependent on environmental conditions, population growth, and the availability for surplus production (Johnson and Earle 2000). These factors affect the potential of growth and power associated with the heads of the chiefdom.

Interregional Exchange Model

Mechanisms of Exchange

The mechanisms that affect the rate of growth and expansion of Olmec polities into interwoven hierarchies are hypothesized to coincide with theories on social competition. The social competition is based on relations and interactions in the community, the region and the area with positive and negative discourse dependent on trade, marriage, and warfare (Clark and Blake 1994). The competition brought on by these groups is a necessity for the scale of interaction observed in the Olmec culture. Barbara Stark (2000: 35) states, “no historic chiefdom matches the degree of mobilization of public labor and specialist skills that are indicated by Gulf Olmec ‘art’ and architecture”. This creates a unique opportunity to learn about an incredibly diverse and complex set of intra- and inter-relationships that change the sociopolitical atmosphere of the entire region. Through an adaptationist model presented by Brumfiel and Earle (2008: 2) on specialization, exchange and social complexity, they believe that the relations demonstrated between Olmec centers and polities located beyond the region were dependent on the concept that “centralized leadership develops to sponsor long-distance trade”. This emphasis on trade opens up discussion on the relative position of the Gulf Coast Olmec to groups in other regions. What was the basis of relationships and why do we see Olmec-influenced material beyond the Gulf Coast? What mechanisms served to perpetuate these relationships and how were these relationships continued throughout the Formative period? A direct form of evidence for these questions comes from the long distance trade of prestige goods. Kent Flannery (1967) attributes relationships between Gulf Coast Olmecs and groups located in Oaxaca on the basis of tradable goods, which would hold far more value (societal and religious) than previously conceived as strictly economic. I will now focus on one crucial discussion (Flannery 1968) to analyze the relationships with groups located outside the Olmec heartland and exchange as a principal mechanism for interaction as a means for sociopolitical aggrandizement of Gulf Coast Olmec elites.

In Flannery's paper presented at the Dumbarton Oaks Conference on the Olmec entitled "The Olmec and the Valley of Oaxaca: A Model for Interregional Interaction in Formative Times", he attempts to contradict the current theoretical position that the interaction in the Valley of Oaxaca represented "invasions, missionaries, or colonization by an 'Olmec elite'" (Flannery 1968: 80). The basis of this theoretical position was propagated by the belief that the highland neighbors living in Oaxaca were far less sophisticated than their Gulf Coast lowland neighbors on the basis of Olmec-Influenced artifacts and monumental carvings found at the highland centers. These highland centers were classified as being subjugated by the far more technological and advanced Olmec of the Gulf Coast lowlands. In his efforts to analyze the relations between the Olmec and groups of the Oaxaca Valley he first outlines three positions, which contradict the belief that these societies were far less developed than the Olmec of the Gulf Coast. First, societies in the Oaxaca valley had a successful agricultural system, which was far different from those represented in the Gulf Coast. Due to the successful agricultural system by 900 B.C., the Valley of Oaxaca produced some of the largest Early Formative sites known in the highlands, exhibiting a population explosion, massive construction, and an agricultural system independent of direct evidence of Olmec influence. Second, the Valley of Oaxaca and the Olmec shared similar settlement patterns accounting for the creation of large, nucleated villages. The previous knowledge of Oaxacan Valley settlement patterns only suggested scattered, small hamlets (Flannery 1968). Third, both the Valley of Oaxaca and the Olmec area exhibited disparities in wealth and status between communities at an early stage. On the basis of these three positions, Flannery contradicted the prior beliefs associated with the sociopolitical position of societies in the Valley of Oaxaca and demonstrated that both the Olmec Coast and the Valley of Oaxaca were similar in their state of sociopolitical position. Flannery then asserts that the model pertaining to the exchange of exotic raw materials as the basis for the development of social stratification between both areas (Flannery 1968).

The model of exchange was based upon material found in context at sites in the Valley of Oaxaca and in the Gulf Coast. The most common connection between the Valley of Oaxaca and the Gulf Coast was based on the sharing of concepts about religion, symbolism, and status paraphernalia (Flannery 1968). Olmec motifs are commonly used on Oaxacan ceramics, and settlement orientation is consistent with that found at La Venta. Most importantly, the Olmec elite would have imported foreign magnetite and ilmenite for the production of small flat mirrors found in Olmec contexts at San Lorenzo Tenochtitlan and La Venta, while the Oaxacan elites would have wanted the shell acquired from the Gulf coast. Magnetite and ilmenite are not local to the Gulf coast region, but can be found in the Oaxacan highlands. The fact that mirrors were found in association with probable ritualized assemblages in the Olmec area signifies the relative importance of the raw material. The basis of the relationships between the Oaxacan highlands and the Gulf Coast was perpetuated by the acquisition of the exotic raw materials. In the course of formation of these exchange networks, elite in the Oaxacan highlands would adopt and adapt the Olmec motifs in their own culture in order to perpetuate the relationships between the two entities, as well.

Jadeite in Olmec Society

In the New World, all jadeite originates from only one specific region: the Montagua River valley of Guatemala. This area would have been highly active with Pre-Columbian groups controlling the output of jadeite in Mesoamerica and Central America. It is important to note that the term “jade” refers to a variety of mineralogical distinct types of stone. Jade is used to describe a large variety of tough, multi-colored, compact gemstones (Foshag and Leslie 1955).

There are two distinct species of jade which include "the pyroene species and its varieties diopside-jadeite and chloromelanite, or to the amphibole species tremolite-actinolite (nephrite)" (Foshag and Leslie 1955: 81). The Motagua River Valley jadeite refers to the pyrone species and its variants. There are no known sources in the New World of the amphibole species. The amphibole species is found in Asia and is characterized by its apple-green or emerald-green color schemes. However, the color schemes of jadeite in the New World vary tremendously, with colors ranging from bluish-gray, greenish-gray, pale pearl-gray, bluish-green pale grayish-green, dark ivy-green to yellowish-green (Foshag and Leslie 1955). The jadeite found with Olmec and Costa Rican assemblages coincides with jadeite's varieties of bluish-green, pearl gray, bluish-gray, greenish-gray, or dark ivy-green. In a study conducted by Seitz *et al.* (2001), they attribute most of the jadeite used by the Olmec and other formative groups as coming from known sources located in the Sierra de las Minas and highlands south of the Motagua River valley.

According to Bernal (1969), the Olmec were the first and finest sculptors of greenstone in Mexico. Their expertise in crafting an incredibly difficult stone speaks to their masterful workmanship and craftsmanship in manipulating and shaping the stone. Mathew Stirling describes the Olmec as having an:

> apparent disregard for the difficulties involved, the tough material was mastered as though it were a plastic. This is in contrast to most later American jadeite products where obvious concessions were made to the original form of the material and the finished products usually had a rigidity not present in Olmec art (Bernal 1969).

Olmec craftsmen would have worked greenstone into a multitude of different objects with each holding economic, social, political, or religious value. Much of the greenstone work is comprised of celts, figurines, beads, ear spools, pendants, and numerous roughly shaped pieces of stone unable to be interpreted (Diehl 2004). One of the most iconic Olmec assemblages of jadeite came from excavations conducted by Drucker, Heizer and Squier at La Venta in 1955. The assemblage of artifacts (labeled Offering 4) consisted of incredibly well-crafted jadeite celts and figurines (Figure). The most widely acknowledged greenstone object, which is iconic of Olmec culture, is the celt. Hundreds of these objects have been found in funerary or religious offerings at La Venta, El Manatí, La Mercades, and several more sites in Chiapas (Diehl 2004). All celts are extremely well crafted with smooth edges from extensive polishing and many exhibit engravings of principal iconographic themes depicting elite rulership and possible cosmological reference. The actual function of the objects is not the utilitarian, but rather ceremonial or religious. Karl Taube infers that some greenstone celts represent carved images of the maize deity and could signify an active representation of the fertile environment (Diehl 2004). The carved images depicted on the greenstone celts have a direct correlation to their cosmological belief systems based on the repetition of notable iconographic characteristics and designs.

The Olmec also manufactured intricate greenstone three-dimensional figurines that depict animal and human images (Diehl 2004). The most common images reflect stylized human forms, jaguars, or “were-jaguars” which range in a variety of different poses from sitting, standing, to kneeling (Diehl 2004). The depiction of the Olmec “Were-Jaguar” compiles different aspects of human features as well as jaguars. The most common features attributed to jaguars include fangs, claws, and other feline features. Archaeologists speculate the significance behind the representation of were-jaguars. Most interpretations attribute the were-jaguar as representative of a shaman transforming into the actual creature. This commonly held belief stems from Daniel G. Briton’s (1984) ideas of many Native American cultures depicting naguals or “shape-shifters”. The Olmec craftsmen utilized an extremely refined skill in crafting these incredibly beautiful figurines. Many figurines exhibit finely incised line work, which could represent body modification or tattoos (Diehl 2004).

Olmec artisans also created greenstone masks, which would be incorporated into ritualized dress. There are two categories of masks made by Olmec artisans. The first is actual full-sized masks, while the second consists of smaller maskettes designed to be suspended on clothing or worn as jewelry. The stylistic designs depicted upon the masks differ between naturalistic representations of possible portraits of individuals and a large portion that reflect the stylized representations associated to the natural world including many with animal features and characteristics. Unfortunately, all masks that have been documented and interpreted have lost their original context, and few have been excavated with archaeological methods. However, archaeologists have been able to compare the actual greenstone artifacts with maskettes depicted on monumental stone carvings, including the San Martín Monument 1 and La Venta Monument 44 (Diehl 2004). Having the ability to compare and contrast the probable functions of the maskettes and masks offers the chance for archaeologists to correlate meaning and function to the greenstone artifacts.

The last category of greenstone artifacts includes those associated with personal ornamentation and probable ritual paraphernalia. These would include “ear ornaments; chest pendants; perforated celts worn on belts; and oblong spherical beads used in necklaces, bracelets, and aprons” (Diehl 2004: 134). There is a large collection of Olmec greenstone artifacts classified as Olmec “spoons”. Olmec spoons were elongated objects exhibit a deep concavity carved at one end of the object and perforated holes on the other end signifying the objects were worn in some fashion (Diehl 2004). An elite class or religious leaders to signify their importance in the society would have most likely worn these objects. Since most greenstone was acquired from far distant sources in Guatemala, the cost associated with these objects was high.

The Costa Rican and Olmec jadeite enigma has perplexed archaeologists in their attempts to explain the large amount of Olmec-influenced jadeites found in funerary complexes in Costa Rica. Archaeologists in Costa Rica interpret the spread of Olmec influence to mean the presence of a complex and distinctive art style recognized in many parts of Mesoamerica during the Middle Formative Period (900 to 400 B.C.) (Graham et al. 1999). The fundamental questions that Michael Snarskis suggests when attempting to understand the relationships between Olmec/Costa Rican jadeite objects include:

> (1) What was the source of raw material for Olmec jadeites?; (2) Why do so many Olmec and fine Costa Rican jadeites have the same or similar deep blue-green color as well as a more three-dimensional sculptural style, including some shared motifs and,, most likely, symbolism?; and (3) What were the cultural dynamics and mechanism that brought Olmec jadeites to Costa Rica but apparently not to the intervening regions, and why is there a chronological discrepancy of as much as a thousand years between the height of Olmec culture and the known contexts of Olmec-style jadeites from Costa Rica? (Snarskis 2003: 162)

The amount of Olmec material in Costa Rica needs to be explored further to stipulate the types of relationships these groups could have shared (if any) to interpret the complexities in correlation to Mesoamerican and Central American exchange networks.

Currently, there are a number of hypotheses that attempt to explain the complexities in relation to the jadeite occurrence in Costa Rica. Before attempting to discuss the relations between Olmec jadeite and Costa Rica, I want to first focus on an analysis of possible forms of relationships between Central America and Mesoamerica. In Winifred Creamer's, "Mesoamerica as a Concept: An Archaeological View from Central America", the attempt is made to compile all relevant theoretical models to explain the relations between Pre-Columbian groups in Mesoamerica and Central America. Six potential models are compiled by Creamer and include work from a number of specialists in the area. The six include the frontier and boundary model; the interaction sphere model; local evolution models; acculturation; core and periphery distinctions; and the world system model (Creamer 1987). In my opinion, the most convincing model to interpret the complex relationship with Olmec culture and Costa Rica groups is the interaction sphere model.

The interaction sphere model was first proposed as an alternative to the diffusion based culture area model, which was applied to groups outside of the Mesoamerican area. The model states that "intergroup contacts such as trade, warfare, and shared symbols of wealth and status illustrate contact among groups that may have differed in all other aspects" (Creamer 1987: 46). This refers to the distribution of unique and exotic goods, which required a specific skill of craft specializations and would have been circulated through Mesoamerica, Central America, and northern South America. Creamer actually uses the Olmec/Costa Rican Jadeite Enigma as one of her defining examples to explain the Interaction Sphere Model. According to Creamer, it is difficult to accurately interpret the whole interaction sequence due to a small sample size of available Olmec-influenced material and the occurrence of jadeite that was reworked before its final deposition (Creamer 1987). However, archaeologists have established that the epi-Olmec style jadeites were appearing in Costa Rican burial contexts as early as 300 B.C. Since a chronological starting point has been established, we can infer that jadeite appeared to have an actual value to groups in Central America. Unfortunately, due to the limited number, we can only assume that Olmec jadeites were a minor trade item. More evidence defined by an archaeological study is needed to determine actual relations between populations representing the Olmec culture and populations in Costa Rica. According to Graham (1998), there have not been any significant artifacts (monumental sculpture, rock-art or cave) found in relation to

Olmec culture in Costa Rica. Also, there is no evidence to support the idea that the arrival of the jadeite objects to Costa Rica was contemporaneous with their manufacture. Finally, the local jadeite carving tradition in the 300-year time frame is still not fully understood. Ultimately, their needs to be more evidence established to infer the possibility of direct relations between Olmec and Costa Rica populations. The existing evidence suggests a long temporal time frame in which the jadeite objects would have been constantly traded, manipulated, and symbolically redefined before their final deposition in burials of Costa Rica. Through a careful analysis of the artifacts, archaeologists are able to reconstruct the lifespan of these unique and highly valued artifacts to better understand the possibility to answer the large societal relations questions.

Concluding Remarks

Through a discussion of the sociopolitical position of the Olmec and their interactions with outside regions, the exchange network model is suggested to have influenced the sociopolitical organization of the elite in the selected regions. The purpose for focusing on the exchange of exotic goods is that it reinforces the control and status of the elite. Kent Flannery asserts that when studying such a system "we must be careful to distinguish between the *purpose* of the participants' behavior, which may be quite easy to figure out, and the *function* of that behavior in an adaptive sense" (Flannery 19y67: 107). The purpose associated with the accumulation and exchange of elite goods, such as the magnetite and ilmenite mirrors, obsidian cutting implements, and jadeite objects, was to reinforce the status of the individuals who were manufacturing, trading, and withholding the objects. The function of the exotic exchange network was to identify a generalized form of "wealth" that could be used to set up reciprocal obligations between the communities controlling the processes of exchange (Flannery 1968).

The role of La Venta and its huge assemblages of jade and other exotic materials could be a result of their elite controlling the market on exotic goods. Many of the jade, serpentine, magnetite, and obsidian artifacts were buried to directly take the materials out of circulation (Flannery 1968). The act of removing these items from circulation could have been a decision to decrease the availability of such items instituting Olmec control and ascribed value. The overall function of this system was to establish economic control by ascribing religious importance to these items and controlling the outflow of these items to regions beyond the Olmec heartland. The principles behind the inter-regional exchange model make it possible for continued acquisition of desired materials for the purpose of establishing status to an elite; however, the function of the system was to ensure the continuation of the exchange of the exotic materials. The rich assemblages at La Venta could indicate a centralized area of distribution of these exotic goods through an elite control of the economic market.

Chapter 4: Methods of Research

My study of Squier's 1964 excavations at La Venta was based primarily on archived documentation. I undertook an analysis of obsidian artifacts in order to assess the research potential of the collection as a whole and its relevance to theories about Olmec culture.

Archival Research

The archival research consisted of documentation, organization, reference gathering, and museum touring. Work was completed at a variety of institutions, libraries, and archaeological sites. The institutions included the University of Kansas Archaeological Research Center (ARC), Sitio de La Venta (INAH), Parque Museo La Venta, Museo Regional de Antropología Carlos Pellicer Cámara, and the Comalcalco Archaeological site museum, and Biblioteca Jose Maria Pino Suarez as well at the research library at the Museo Regional de Antropología Carlos Pellicer Cámara. These institutions were helpful with providing relevant background knowledge on Olmec literature, full access to all documentation on the archaeological excavation conducted by Squier, as well as a notable history of their involvement with the procurement and curation of artifacts in relation to La Venta or archaeological collections that show Olmec influence.

The ARC offered the first opportunity to work with all relevant documentation, photographs, and collections representative of Squier's 1964 collection. Much effort was made to fully categorize and organize all relevant documentation in relation to Squier's archaeological contributions spanning his whole career. In the course of six months, Steven Keehner, a fellow graduate student, and I devoted time to organizing, separating, and reading all documentation the Squier family donated to the ARC. The full donation included field journals, excavation documentation, correspondence, financial records, publications, developed photographs, photograph negatives, maps, and personal notes spanning the entirety of Squier's career as a graduate student, field technician, professor, and academic scholar at the University of Kansas and other institutions. This opportunity gave me a first hand experience in proper curation protocols and techniques. The ability to fully categorize and organize relevant documentation is a vital step before attempting to complete a research project.

Lab Analysis

Once the documentation, maps, and photographs were organized, the next step was to correlate the artifacts recovered from the 1964 excavations to the archival materials. The materials excavated from the 1964 collections were kept in good condition, with site name, year, pit classification and excavated level written on every bag. Surprisingly, after correlating the original artifact catalogs, all bags representative of Pit C were accounted for, based on their level classification. All bags labeled “Pit C” were removed and rehoused in corresponding boxes with their respective excavation levels. After over fifty years of storage, to have a full collection of all excavated materials from Pit C was a significant aspect that made research a feasible endeavor.

The initial objective of my research project was to organize and quantify the Pit C collection to identify ceramic sherds representing good candidates for future research. Artifacts from each excavation level were carefully separated in relation to their material type. My classifications used to organize Pit C included bitumen, bone, ceramic, chipped stone, obsidian, charcoal and ground stone. Once classified, each bag was separated by level, then quantified based on these material classifications. Gloves were worn at all times in hopes to lessen the effect of cross-contamination of the selected ceramic sherds. Artifacts were grouped by material type and were re-bagged in museum polyethylene bags.

Ceramics were further separated by prior ceramic analysis investigations by diagnostic rims, non-diagnostic rims, diagnostic body sherds, and non-diagnostic body sherds. Sherds that exhibited potential for ceramic residue analysis were further separated. After completion of the primary collection material, I rehoused and quantified diagnostic artifacts, which included figurine pieces and restorable vessels. Due to restrictions on time and available funding, a completion of a ceramic residue analysis was not a feasible research endeavor. However, after the organization of the collection, the obsidian recovered and documented seemed to be a logical alternative to pursue potential research on source identification.

Obsidian Source Analysis

Obsidian is a super-cooled liquid composed primarily of silicon dioxide (SiO_2) that forms as a result of the high temperatures produced in volcanoes. Ericson et al (1976:218) defines an obsidian source as “a single volcanic event such as an obsidian-perlite dome, flow, aerial bomb scatter or sedimentary stratum containing obsidian” (Hughes 2008: 104). Its specific chemical composition varies from source to source on the basis of local geology, but this composition tends to be relatively uniform throughout specific obsidian flows. That is, there is significant uniformity in a particular obsidian deposit, but variation among different obsidian flows. This has lent itself to characterizations of specific obsidian sources in a variety of geographic locations. Recently, the assumption of a homogenous source identification associated to specific deposit has been contested (Ferguson 2011). As research has progressed through the last few decades on identifying the compositional elements represented in deposits, variability among geophysical properties becomes apparent. Richard E. Hughes (1998) describes the problems associated with Ericson et al.’s original definition by the geochemical properties of these sources. Hughes (1998) describes “(1) sedimentary strata may, depending on local geologic factors, contain obsidians of different chemical types that may themselves be redistributed far from their original eruptive home(s), and (2) it fails to consider that the geologic processes involved in the formation of obsidian in ash-flow sheets may result in the distribution of multiple *primary sources* across a vast geographic space" (104). Since obsidian sourcing relies heavily upon geochemistry, the primary goal of obsidian sourcing is to recognize a "chemical group" describing a distinct cluster of obsidian representing a specific area of occurrence (Hughes 1998).

Over the last few decades, obsidian sourcing has become a vital methodology utilized when addressing questions associated with the archaeological record. The use of obsidian sourcing methodologies upon archaeological material has significant implications when trying to hypothesize "migrations, exchange relationships, and tool production, use, and discard in a spatial context" (Ferguson 2011: 402). Archaeology has utilized and refined these methodologies through provenience studies of obsidian all around the world. Substantial obsidian source identification in Mesoamerica since the 1970s has resulted in the confirmation of 37 well-documented sources. These have been documented over the years using a variety of sourcing methodologies including Inductively Coupled Plasma Mass Spectrometry (ICP), X-Ray Fluorescence (XRF), and Neutron Activation Analysis (NAA) (Glascock and Ferguson 2012).

In preparation to send the obsidian artifacts to the University of Missouri Research Reactor Archaeometry Laboratory, the samples needed to be fully categorized under a strict set of guidelines in order for sample submission. The new categorization included all relevant information for each artifact including: a specific artifact classification number (GBL001-GBL072), alternate ID number (100-113), region (Mesoamerica), country (Mexico), sub-region (Gulf Coast Lowland), site (La Venta), material type (Obsidian), description (Artifact Type), culture (Olmec), context (Pit C), provenance (Excavation Level), period (Chronology), date (Excavation Date), latitude and longitude of site. Each artifact was bagged separately with relevant identification to avoid confusion when transporting to the Archaeometry Laboratory. Since the analysis of the obsidian artifacts is a non-destructive procedure, I did not need to take extra precaution documenting the material. However, in my own analysis of the collection, I took created a detailed spreadsheet accounting for the original ID number during the curation process, , weight (grams), length (millimeters), width (millimeters), thickness (millimeters), color, and any relevant comments. In the event of artifacts being mixed, my extended analysis ensured I had an alternative method for correctly identifying unknown artifacts.

A total of 72 obsidian samples (GBL001 to GBL072)—the complete assemblage from Pit C, were submitted for source identification. Jeffery R. Ferguson, Research Assistant Professor, ran the samples and generated a report (see Appendix A) upon conclusion of the analysis. Source identification was accomplished through the use of XRF. The minor and trace elements included in the analysis were rubidium (Rb), strontium (Sr), zirconium (Zr), niobium (Nb), and yttrium (Y). These five elements were chosen due to their significant amount of variation between identifiable sources, which makes them useful for defining specific chemical "fingerprints". A statistical analysis was then carried out by MURR (see Appendix A for full explanation) on all seventy-two samples in order to identify distinct clusters in the observed specimens and to then compare these clusters to the chemical signatures of known geologic sources.

Chapter 5: Obsidian Analysis

Results of Obsidian Source Analysis

Jeffrey Ferguson of the University of Missouri Research Reactor Archaeometry Laboratory (MURR) concluded that of the 72 obsidian specimens submitted for analysis, 71 samples yielded known source identifications while one could not be identified as representing the chemical signature of obsidian. The report (Appendix A) describes the compositional analysis, source assignment, and interpretation of 72 lithic artifacts (GBL001-GBL072) excavated by Squier in 1964 from Middle and Late Formative contexts at La Venta. During the excavation, there was no mention of any obsidian being found in the Early Formative excavation levels. The obsidian samples were sourced by comparing trace elements to the extensive database of known sources in the immediate area of La Venta. The sources observed correlated well with previously identified source identifications for other obsidian from Olmec sites.

The identification of likely sources was based on relative concentrations of major and trace elements that represent the chemical signatures of distinct geological deposits of obsidian in Mexico and Guatemala. According to Ferguson, the chemical signatures of each specimen are grouped upon their compositional elemental data in order to see notable relationships and assign probable source identifications. The 71 specimens of obsidian yielded seven distinct source identifications (Figure 8), which are distributed throughout Mesoamerica. The locations of the seven identified sources correspond with Figure 9. The seven identified are: 1) Paredón (n= 34 or 34%), 2) San Martin Jilotepeque (n= 22 or 31%), 3) Pachuca (n= 5 or 7%), 4) Pico de Orizaba (n= 5 or 7%), 5) Otumba (n= 3 or 4%), 6) El Chayal (n= 1 or 1%) and 7) Guadalupe Victoria (n=1 or 1%). These findings correlate well with a study completed by Travis F. Doering (2002) at San Andres, which is near the center of La Venta. Doering's results concluded that the

Paredón and San Martin Jilotepeque obsidian sources were highly exploited by the populations in San Andres during the Middle Formative Period.

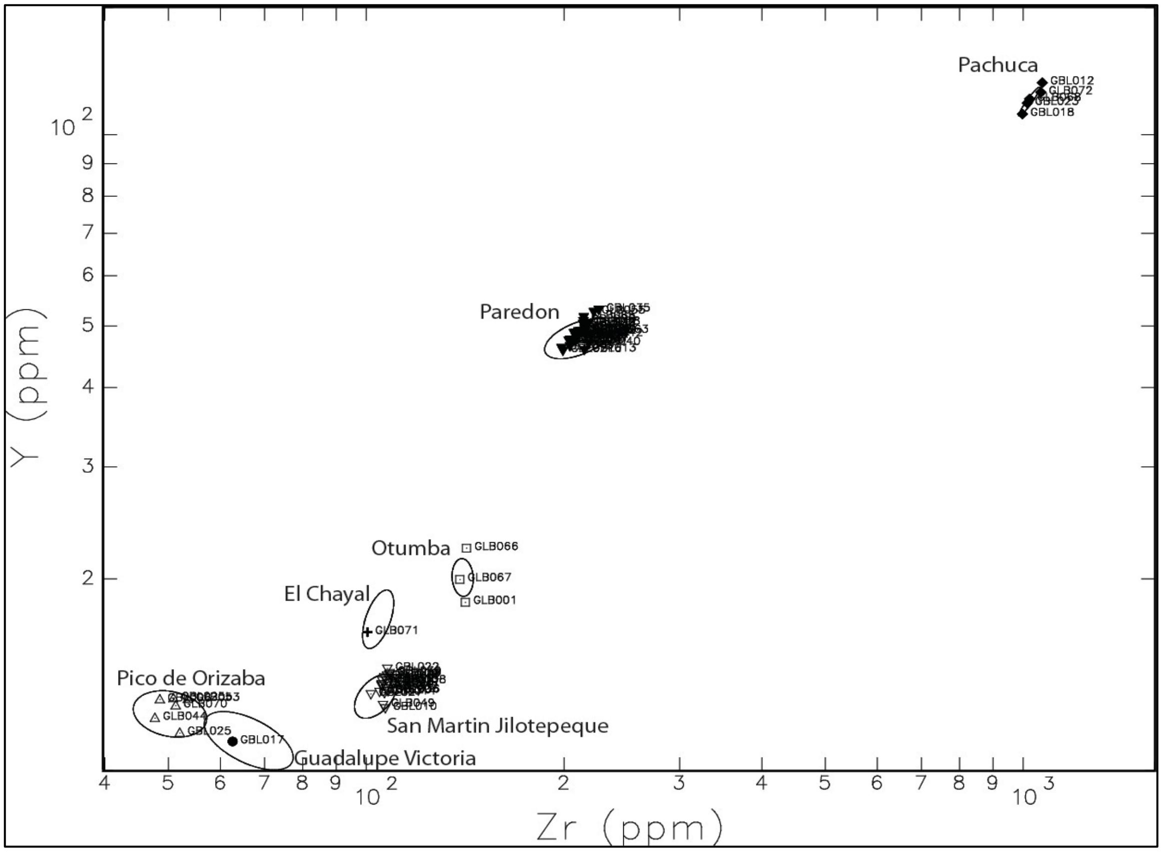

Figure 8. Scatterplot of zirconium and yttrium concentrations for the obsidian artifacts and sources. Artifacts are individually plotted and labeled. Sources are represented by ellipses only. Ellipses represent 90 percent confidence intervals for membership in the groups

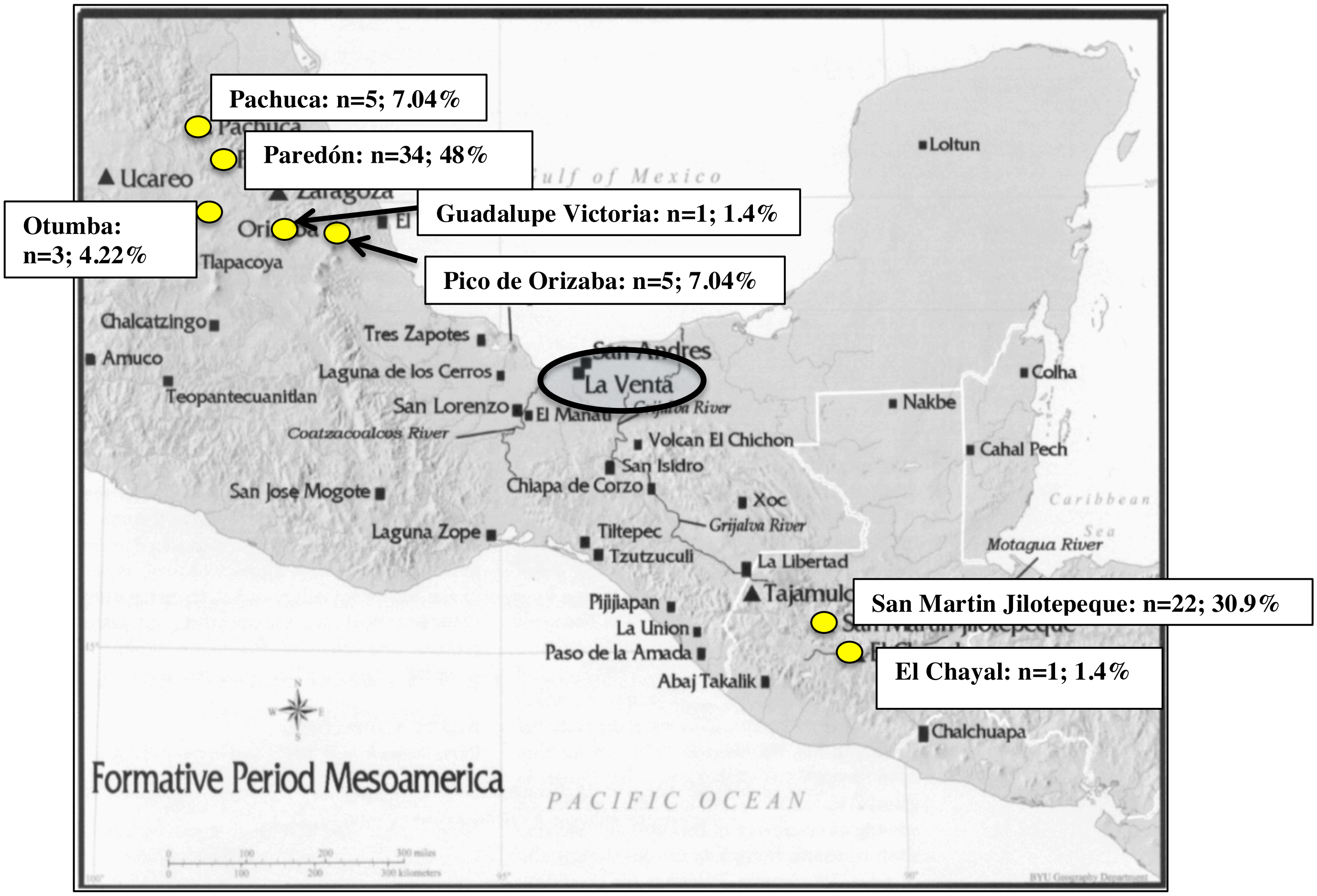

Figure 9. Source locations of identified obsidian (after Doering 2002)

The collection of obsidian represented in Pit C of the Squier collection varied in artifact type. From my analysis, I deduced six type classifications based upon the artifacts represented. These six artifact types including bifacial tools, blades, blade fragments, flakes, shatter, and an unidentified artifact I classified as a “gaming piece”. The breakdown of the assemblage based upon artifact type and source can be seen in Figure 10. The data supports a few distinct patterns associated with obsidian tool types and chronology. Of the sources represented in the Squier collection, Paredón and San Martin Jilotepeque contribute the main proportion (n = 56 or 62%) of blades from contexts dating from the Middle and Late Formative Periods (Figure 11).

Artifact type	El Chayal	Guadalupe Victoria	not obsidian	Otumba	Pachuca	Paredon	Pico de Orizaba	San Martin Jilotepeque	Grand Total
Bifacial Tool						2			2
Blade						1			1
Blade Fragment		1		1	1	17	1	17	38
Flake	1		1	1	3	12	4	2	24
Gaming Piece					1				1
Shatter				1		2		3	6
Grand Total	1	1	1	3	5	34	5	22	72

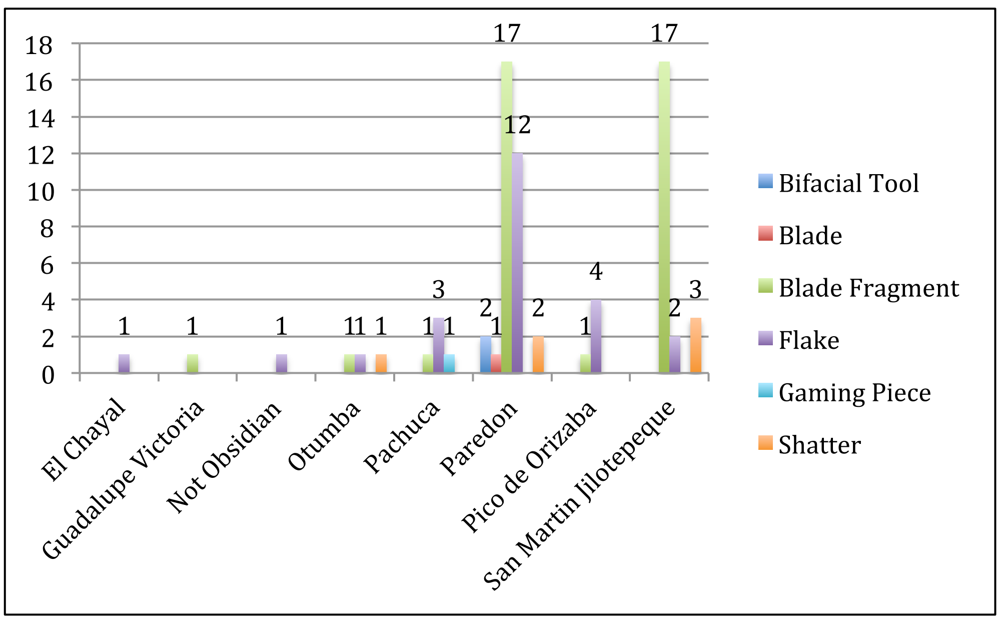

Figure 10. Breakdown of assemblage by source and artifact type

Period	El Chayal	Guadalupe Victoria	Not obsidian	Otumba	Pachuca	Paredon	Pico de Orizaba	San Martin Jilotepeque	Grand Total
Late Formative		1		1	3	12	2	12	31
Middle Formative	1		1	2	2	22	3	10	41
Grand Total	1	1	1	3	5	34	5	22	72

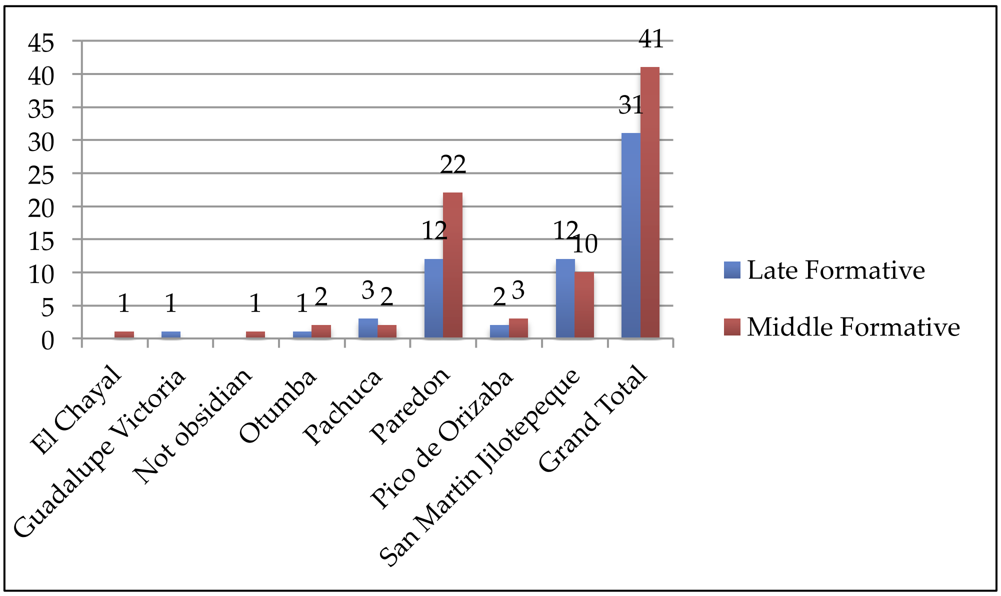

Figure 11. Breakdown of assemblage by source and time period

Obsidian in Olmec Society

The procurement and distribution of obsidian in Mesoamerica is a complex and historic process. Due to limited access to readily available lithic resources in Mesoamerica, obsidian became the most widely utilized material type for lithic tool production. Obsidian would have held a utilitarian and ceremonial function in Pre-Columbian societies. Utilitarian functions included “scrapers, knives, perforators, burins, gravers, dart and arrow points, and razor sharp blades for shaving and haircutting” (Ponomarenko 2004: 85) while ceremonial functions included “ornate eccentrics and large finely chipped biface knives for ritual bloodletting and human sacrifice” (Ponomarenko 2004: 85). Most Mesoamerican assemblages of lithic tools contain a high frequency of locally acquired stone flakes or obsidian blade fragments (Clark 1987: 259). Ultimately, the lithic assemblages from Mesoamerican contexts are quite simplistic due to the low occurrence of specified lithic tool types. Flaked tools are scarce in Mesoamerican assemblages, from all cultural groups. According to Clark (1987), the replacement of flake technology with the highly specialized manufacture system associated with blade technology occurred in the context of the Mesoamerican Formative Period. Due to the occurrence of complex chiefdoms, the available mechanisms associated with exchange, political affiliation, and specialized craftsmanship led to the overly abundant blade technology, which would triumph over all others in the preceding centuries. Clark (1987) considers the creation of prismatic blade technology as the height of the flaked-stone technology in Mesoamerica, representing a critical shift in terms of resource procurement and the efficiency in tool manufacture and replication.

The Olmec would have utilized, controlled, and exploited the market of obsidian in the Formative Period in the Gulf Coast lowlands. Clark (1987) associates the beginning of complex chiefdoms in Mesoamerica with the beginning of exchange and production of blade technologies. The Olmec chiefs had the means to “finance” blade technologies, which included “subsidizing craft specialists, overseeing interregional trade, negotiating with foreign chiefs for obsidian, regulating distribution of obsidian blades made by specialists” (Clark 1987 278). Through the acquisition of these materials, archaeologists are able to access the source identification to test the theories associated with the Olmec and their role in the obsidian exchange network. Obsidian blades would have held a high value in the context of Formative society because of the amount of time, specialization and effort needed to produce one blade. Two notable studies will be discussed to compare their results with that of the 1964 La Venta collection's account for the inter- and intra-relationships fostered through obsidian blade technology. These studies include Hirth *et al.* (2013), entitled "Early Olmec Obsidian Trade and Economic Organization at San Lorenzo", as well as Poole *et al.* (2014), "Formative Obsidian Procurement at Tres Zapotes, Veracruz, Mexico: Implications For Olmec and Epi-Olmec Political Economy". These recent studies examine the potential for obsidian source analysis to elucidate the political and economic systems reflected by obsidian craft specialization in two principal Olmec centers: San Lorenzo and Tres Zapotes.

There has been a multitude of prior studies (Cobean *et al.* 1971, 1999; Hirth *et al.* 2013) accounting for the procurement and distribution of obsidian at the Olmec center named San Lorenzo Tenochtitlan. In these studies, the focus was to establish a relatively credible methodology of artifact and source identification system for obsidian at the site. San Lorenzo Tenochtitlan represents a complex of three sites located in southern Veracruz, Mexico (Cobean *et al.* 1971). Societal development at the site occurs between 1800 and 600 cal. B.C. The chronological history of occupation and expansion has been well documented and is separated by a series of well-defined phases supported by radiocarbon and ceramic seriation. The sequence of phases includes: the Ojochi phase (1800-1600 cal. B.C.), the Chicharras phase (1500-1400 cal. B.C.), the San Lorenzo A phase (1400-1200 cal. B.C.), the San Loerenzo B phase (1200-1000 cal. B.C.), and the Nacaste phase (1000-800 cal. B.C.) (Hirth *et al.* 2013). The initial studies conducted by Cobean *et al.* (1971, 1991) provide two crucial contributions to Mesoamerican obsidian research. First, Cobean *et al.* (1971) successfully conducted a source analysis on a small set of obsidian artifacts. Second, Cobean *et al.* (1991) provide the chemical composition of 25 previously unknown obsidian sources in Mexico and Guatemala. Hirth *et al.* (2013) acknowledge three reasons why obsidian source analysis plays an important role for reconstructing economic systems:

"(1) obsidian is the only material resource that permits highly accurate reconstructions of raw material movement from its final point of consumption; (2) obsidian was used for cutting tools in many areas of Mesoamerica where local silicates such as chert or rhyolite were unavailable; (3) obsidian is one of the few materials that can withstand the highly corrosive effects of the Gulf Coast environment" (2785).

The results of research conducted by Hirth *et al.* (2013) and their analysis of 852 obsidian artifacts expanded their knowledge about obsidian procurement in two ways. The first was the appearance of an interregional exchange network for obsidian as early as the Ojochi phase (1800-1500 cal. B.C.) (Hirth *et al.* 2013). There was an identified presence of both Mexican and Guatemalan obsidian artifacts in the earliest phase at San Lorenzo. The most significant was the El Chayal source from highland Guatemala over 613 km away from San Lorenzo. The second discovery was contradictive to Clarke's (1987) statement that obsidian prismatic blade production was a political process controlled by an elite. The results did not reveal a sudden decrease in prismatic blades towards the decline of San Lorenzo in the Nacaste phase. San Lorenzo Tenochtitlan provided significant evidence in the way archaeologists begin to interpret the complexities of the economic system associated with prestige goods in Mesoamerica.

The study conducted by Poole *et al.* (2014) on obsidian artifacts from the Olmec center Tres Zapotes was the first to be published on the obsidian artifact assemblages from the site. The study represents a comprehensive analysis of the identified sources of obsidian artifacts dating from 1200 B.C. to A.D. 300. All artifacts were excavated under controlled archaeological conditions and represented Early, Middle, Late Formative and Protoclassic periods. In total, 180 artifacts represented the total assemblage analyzed for source identification. Five Mexican sources were identified by XRF analysis, while there was no account of Guatemalan sources until the Protoclassic periods (Poole *et al.* 2014). Their results indicated that Olmec elites exhibited some aspect of control in the Formative period. This coincides well with the general hypotheses generated by other Olmec sites in the Gulf Coast regions. Specifically, the evidence of domestic use tends to increase proceeding into the Late Formative and Protoclassic (Poole *et al.* 2014). There seems to be an overall conclusion based on the materials from San Lorenzo, La Venta and its hinterland, and Tres Zapotes that the Middle Formative period was drastically influenced by the control of obsidian situated in an elite context.

Discussion

The data indicates that lithic reduction was not apparent in the confines of the Pit C area. The magnitude of blade fragments suggests that reduction was occurring at an alternative location relative to the final deposition of the specimen. William Rust (2008) suggests that due to the relatively infrequent occurrence of reduction flakes located in the center, La Venta's primary purpose was to serve as a distribution center of obsidian tools to the hinterland sites. Rust found that in specific contexts obsidian occurred 69.6% to 85.4% in domestic contexts at La Venta versus 52.5-86.4% at hinterland sites (Rust 2008). These findings correspond to Clark's ideas on Olmec complex chiefdoms and their involvement with obsidian blade production. La Venta elite would have controlled the process of redistribution of blades to different populations in the area. The elite would have controlled all aspects of obsidian procurement, production and distribution creating a particular market for individual sources dependent on inter-site relations between La Venta and the chiefs controlling the obsidian sources. The ability to analyze the potential for obsidian source analysis and its relations to the political and economic systems reflected by obsidian craft specialization can make it possible to infer and evaluate many potential patterns and relationships between geographically separate groups. Occurrence in the pattern and use of different obsidian sources infers specific social patterns that influenced decisions made by elites. A source analysis of obsidian is vital to track the economic trading systems of highly valued and traded goods throughout the complex framework of Mesoamerican society. I will now discuss the implications of the Paredón, San Martín Jilotepeque, and Pachuca obsidian sources relative to the Squier collection.

The Paredón obsidian source is located is located between the central Valley of Mexico and the Metzitilán valley to the northeast (Charlton et al. 1978). The official discovery of the source was in 1975 from a series of surface surveys accounting for outcrops of small, water-rolled cobbles with heavy cortex along eroded drainages that have been fluvially deposited (Charlton et al. 1978). Pre-Columbian groups have utilized the obsidian source from the Early Formative periods to the Late Post-Classic. Indications of permanent structures or ceramic decries have not been found, however, there is a significant amount of debris from quarrying activities, core preparation, and tool-blank preparation (Charlton et al. 1978). The obsidian is described as "gray in color, varying from transparent to translucent with banding" (Charlton et al. 1978). In Figure 12 labeled "C", is an example of one of the many obsidian artifacts represented in the Squier collection representative of Paredón obsidian. This is the only full blade documented in the collection, and represents a small percentage of the large amount of the Paredón obsidian representative in the collection.

The San Martín Jilotepeque (SMJ) obsidian source is location in the department of Chimaltenango, Guatemala. Braswell and Glascock (1998 describe the source as being exploited by Pre-Columbian groups from the Paleoindian period up until the present day. SMJ has been known by a number of different names throughout the archaeological literature including Aldea Chatalún, Chimaltenango, and Río Pixcayá (Cobean et al. 1991). A large proportion of the SMJ obsidian in the Squier collection were blade fragments ranging in size. The blade fragment (labeled A) in Figure 12 appears to have been significantly retouched on its edge. The frequency of SMJ obsidian appearing from Middle to Late Formative periods at La Venta corresponds with its occurrence at the site of Tres Zapotes. Poole *et al.* (2014) observed a shift to SMJ obsidian during the Late Formative period.

The Pachuca obsidian source is located in the volcanic center Sierra Las Navajas in Hidalgo, Mexico (Ponomarenko 2004). Pachuca obsidian is unique from many other types of obsidian in the area due to its highly distinguishable green color associated with the source. The color ranges from "a translucent bottle green to green-black to a chatoyant shimmering golden-green" (Ponomarnko 2004: 79). Pachuca obsidian is known by a multitude of different names throughout the course of archaeological literature including Sierra de las Navajas, Cerro de las Navajas, Cruz de Milagro, Cerro de Minillas, El Ocote, Huasca, Rancho Guajalote, Cerro Pelon, and the Sierra de Pachuca (Ponomarenko 2004). The source has been highly exploited throughout the course of Pre-Columbian history most notably due to its unique color and quality for manufacture of obsidian crafted tools, more importantly, the exchange of Pachuca obsidian spans "as far south as Copan, Honduras, and as far north as Spiro Mounds, Oklahoma (Ponomarenko 2004: 71). The popularity of Pachuca obsidian rose significantly in the Classic and Post-Classic periods with the expansion of the sociopolitical centers of Teotihuacán, Tula, and Tenochtitlán. However, during earlier periods, Pachuca obsidian was apparent in Formative period Olmec societies in the Gulf Coast as well as in Mirador, Chiapas, Mitla, Oaxaca, and

Cholula, Puebla (Ponomarenko 2004). As indicated in Figure 12, the Pachuca obsidian artifact is unique among the collection of obsidian from the Squier collection. The artifact represents a heavily modified piece of Pachuca obsidian with green/yellow coloration that has been heavy rounded and smoothed on either ends. I suggest the artifact held significance through a representation of status and described the object as a “Gaming Piece”. In Mesoamerica, obsidian was used for high status objects including “laurel-leaf knives, mirrors, sequins, figurines, nose plugs, and ear spools” (Ponomarenko 2004: 85). Since I do not know the actual use of the artifact, the care and attention given to the preparation of the artifacts deems significance in some way.

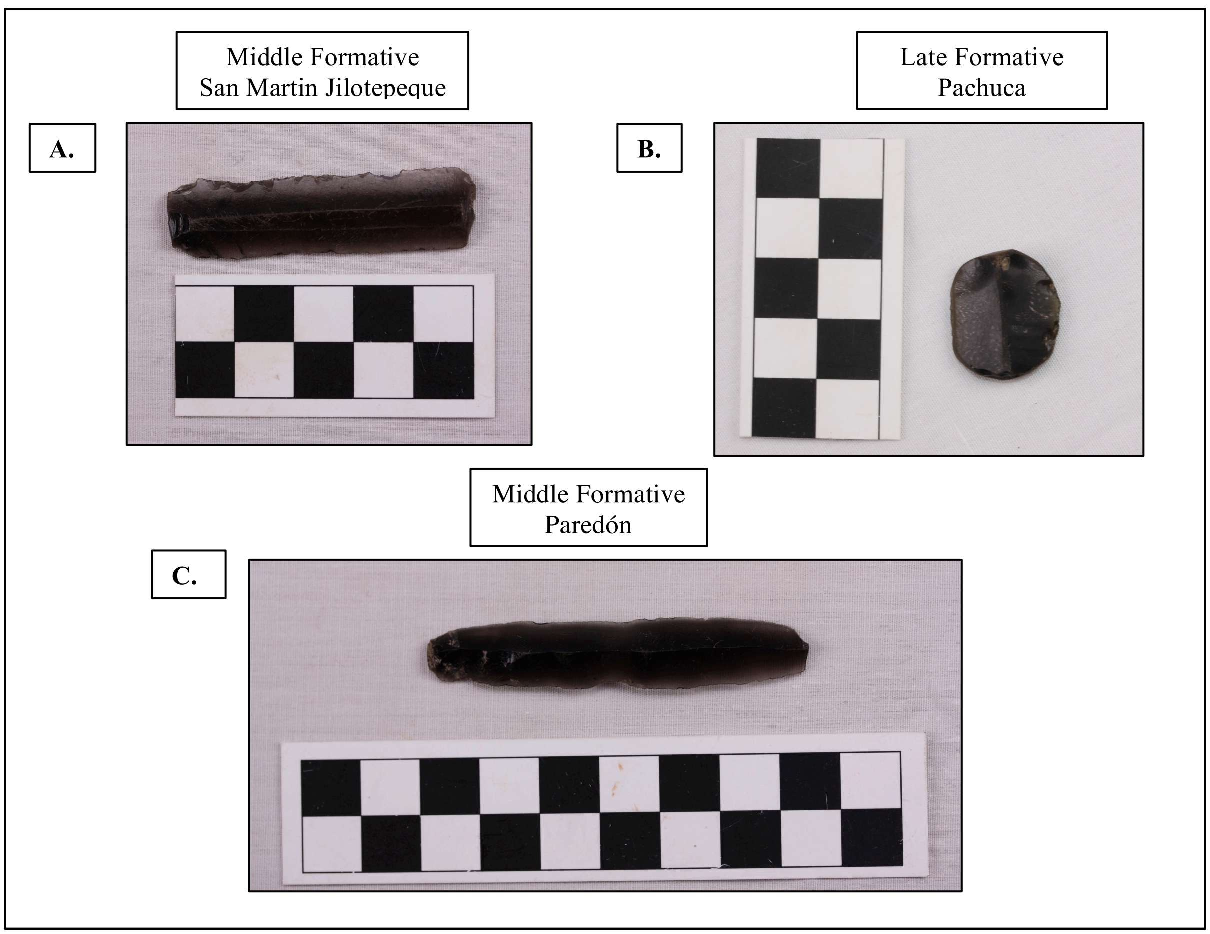

Figure 12. Examples of obsidian artifacts from collection

Chapter 6: Current Studies and Potential for Future Research

Through the re-examination of curated collections with new technological and methodological techniques, new workable and testable hypotheses can be generated in hopes of providing references or new interpretations. When organizing and separating the 1964 La Venta collection, I saw the opportunity for four new methodologies to consider for future research. The methodologies included: 1) sourcing of obsidian artifacts, 2) radiocarbon dating, 3) organic residue analysis, and 4) sourcing of bitumen. Due to available time and funding, I was able to complete a full source analysis of all obsidian specimens in Pit C. However, the remaining pits have not been organized or examined and therefore, the remaining obsidian has not been sourced. The second methodology was a re-analysis of the radiocarbon dates acquired by Squier. Using Atomic Mass Spectrometry (AMS) from residue extracted from ceramic sherds would offer the most accurate radiometric determination. The third methodology would include ceramic residue analysis with the hope of finding highly valued resources such as cocoa or tobacco. The last methodology considered was a source analysis with representative bitumen specimens in the collection. The majority of research methods suggested were based upon other studies on Olmec sites conducted in the area. However, the majority of the suggested research methodologies (obsidian, organic residue, and bitumen) have not been attempted at the center of La Venta.

Re-Analysis of Dating Methods

Due to significant advances in the technology of radiocarbon dating methods since the 1960s, I felt that a reassessment of the original dates acquired by Squier needed to be undertaken.

The original radiocarbon samples from La Venta were analyzed by the UCLA Radiocarbon Lab in the mid-1960s and were successfully determined to provide a range of what were considered to be an acceptable series of dates for a variety of sample types. However, with the creation and refinement of accelerator mass spectrometry (AMS) in the late 1970s, as well as efforts to refine radiocarbon calibration, radiocarbon dating increased its capabilities for evaluating small samples and refining the precision of the dates obtained. The creation of AMS dating brought about three important advantages to the scientific community: (1) the amount of carbon needed to run an analysis significantly decreased from grams to milligrams; (2) the length of counting times decreased from days, weeks, or months to minutes; (3) the sensitivity of analysis increased the potential for dating older material (Taylor 2000: 65). With the advancement of modern technology, researchers need to be constantly questioning their methods in order to receive more specified results. New advances made in radiocarbon dating can be reintroduced to past collections that were made before the current capabilities to test their radiocarbon samples with such refined qualities existed. Squier's decisions about samples from which to obtain radiocarbon dates were directly conditioned by the amount of datable material present to run the analysis. Through the use of AMS dating, a full replication of the dates acquired by Squier can be tested for a second time. For this analysis, samples for AMS dating can be acquired from ceramic sherds that have residue particles adhering to the interior surface. As indicated in one example (Figure 13), visible surface residues were observed on the surface of ceramic sherds from different levels. The capability of extracting charcoal samples from the ceramics and successfully analyzing them offers an entirely new research opportunity with which to clarify the chronological sequence based on ceramics from the 1964 La Venta collection.

Figure 13. Visible surface residue on ceramic sherd (#107)

Ceramic Residue Analysis

The analysis of organic residues on ceramics had not yet become a significant area of research in Mesoamerican archaeology at the time of Squier's fieldwork. Organic residue analysis requires an interdisciplinary approach that includes methodologies and theoretical conceptions spanning biology, chemistry, archaeology, botany, zoology, geology, and many more (McGovern and Hall 2015: 54). Since interdisciplinary perspectives influence the data achieved, the data have implications for many important social, biological, and environmental areas of inquiry. Careful attention must be given to the limited data and the possibility of generating workable hypotheses. Applying an archaeological perspective requires acknowledging distinct limitations in the amount of data available, the condition of the data, and the context from which the data were derived (McGovern and Hall 2015: 56). The approach is not without its problems. Errors can result from a number of anthropogenic and environmental factors that inhibit or contaminate the available data. The fundamental goal of organic residue analysis is recognition and documentation of recognizable biomarkers that have bearing upon the evaluation of the initial hypothesis.

Archaeological biomarkers are organic residues or substances that have direct implications for interpretations of past activities (Evershed 2008: 897). Many derive from food production. These include lipids (fats, resins, and waxes), proteins, carbohydrates, and many more biomolecules (Evershed 2008: 897). However, organic residue analysis can also identify alcohol, tobacco, and ancient DNA. The basic premise behind the recognition of biomarkers is to match the chemical signatures left by archaeological biomarkers with known biomarkers (Evershed 2008: 898). The process involves chromatography and spectrometry.

Gas chromatography in organic residue analysis separates the individual constituents of an organic compound (Malainey 2011: 433). The residue is dissolved into a liquid solution that is passed through a gaseous mobile phase and a stationary phase to isolate its components. The stationary phase is achieved using a chemical filter that separates the components by particle size (Melainey 2011: 433). In gas chromatography, the separation of individual biomarkers is determined on the basis of a specific component's boiling point (Melainey 2011: 437). Once the components of the residue have been separated, further identification of the constituent compounds can be undertaken using from mass spectrometry.

Mass spectrometry is used to identify the ions of various compounds represented in the residue and their proportions in these compounds (Melainey 2011: 416). Both inorganic and organic ions can be distinguished. Molecular mass spectrometry analyzes organic ions while atomic mass spectrometry analyzes inorganic ions (Melainey 2011: 419). Both methods are important for the analysis and interpretation of organic residues because they can identify specific biomarkers.

The survival of residues on ceramics is conditioned by different factors that affect preservation. Organic residues that preserve well are vulnerable to climatic, depositional, and anthropogenic processes that could destroy or contaminate them. Organic residues on ceramics can result from three forms of occurrence: (1) *in situ* vessel interior residues; (2) visible external surface residues; (3) residues absorbed in the vessel wall (Evershed 2008: 904). Visible residues result from the carbonization of organic material either in a vessel or on its exterior (Evershed 2008: 903). Absorbed residues occur when heat causes the biomarker to be absorbed by a vessel wall. All residues are vulnerable to contamination from depositional, climatic, and/or anthropogenic processes. However, the ability to distinguish and characterize archaeological biomarkers can relate directly to important social, political, economic and ritualized spheres of interaction determined upon the resources in which they produce, consume, or distribute.

I will discuss two distinct case studies in an effort to address theoretical issues in Olmec archaeology as well as to demonstrate the benefits of organic residue analysis on a previously unstudied archaeological collection. Organic residue analysis can detect the presence of goods that were highly commoditized and valued in Mesoamerican culture. Two of these are cacao and tobacco. We can test hypotheses about social relationships, economic exchange systems, and the symbolic importance of the substances using the 1964 La Venta ceramics. The first case study is an examination of cacao at the earlier Olmec site of San Lorenzo while the second describes the identification of tobacco in Maya ceramic vessels. The methodologies and techniques employed by the first study have direct implications for the La Venta material; however, the second bears on the prevalence of tobacco use by both Mayas and Olmecs.

In one study (Powis et al. 2011: 8595), cacao residue analysis was performed on ceramic sherds varying in provenience, type, vessel from, and temporal placement from San Lorenzo. The occupation of this site precedes that of La Venta, as indicated by calibrated radiocarbon dates ranging from 1800 to 1600 BC (Powis et al. 2011, 8596). Theobromine is the primary biomarker for cacao, the only Mesoamerican plant that has theobromine as a primary component (Powis et al. 2011: 8595). The utilization of liquid chromatography along with mass spectrometry resulted in 17% of the 154 ceramic sherds sampled testing positive for theobromine (Powis et al. 2011: 8596). As indicated in Figure 14, the forms of positively identified vessels did not coincide. These results demonstrated the presence of theobromine, but did not show how cacao products were consumed. Many studies imply that fermentation of sweet cacao pulp into an alcoholic beverage was the most likely means of consumption. However, significant advances in residue analysis are required to test for alcohol, something not yet possible (Powis et al. 2011: 8597). The use and exchange of cacao in Mesoamerica may have its origins in Olmec society. The 1964 La Venta collection offers an opportunity to further the support of cacao domestication by the Olmec or Olmec influenced groups.

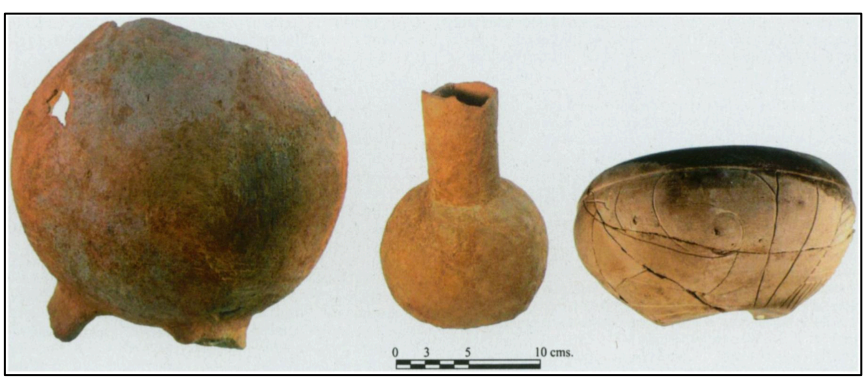

Figure 14. San Lorenzo ceramic vessels indicating cocoa use (Powis et al. 2011: Fig. 4)

The second case study involved the recognition of tobacco in a Maya ceramic vessel. Organic residue analysis was used to identify nicotine, the signature alkaloid of tobacco, in the vessel (Zagorevski and Loughmiller-Newman 2011: 403). Tobacco is an important substance in the Americas and has a variety of consumption techniques including smoking, sniffing, chewing, or as an additive to food and drink (Zagorevski and Loughmiller-Newman 2011: 403). The ceramic vessel, indicated in Figure 15, was unique in Maya ceramic analysis because hieroglyphs on the outside of the vessel suggested a connection with tobacco. Gas chromatography and mass spectrometry were used to identify nicotine in the organic compound and the molecular structures composing the organic compound in order to suggest the condition or state of the tobacco while in the vessel. Specifically, acknowledging the amount of oxidation occurring signifies the burning of the tobacco (Zagorevski and Loughmiller-Newman 2011: 410). The results of the study proved the presence of nicotine in the vessels as well as the un-oxidized state of the molecular compounds inferring the conclusion that the vessel held raw tobacco (Zagorevski and Loughmiller-Newman 2011: 410). The implications of this study in Olmec archaeology are important when discussing the use and symbolic/ritual beliefs associated with the product. Many indigenous groups in the Americas use tobacco as an important

Figure 15. Maya vessel tested for presence of tobacco residue (Zagorevski and Loughmiller-Newman 2012: Fig. 1)

shamanistic tool. In the Maya, iconographic representations of humans smoking tobacco are evident. Generating hypotheses about tobacco use and exchange in the Olmec society could support relevant religious ideologies of future civilizations in Mesoamerica.

By distinguishing the presence of valued products upon Olmec ceramics, a better understanding about the complex exchange system and social relations can be inferred upon. The 1964 La Venta collection has potential for organic residue analysis, however, careful consideration about post-excavation handling techniques need to be considered. In total, five samples (Figure 16) were found to exhibit a good possibility of yielding a residue and possible date. Many more sherds exhibited a probable chance of extracting an identifiable residue. The

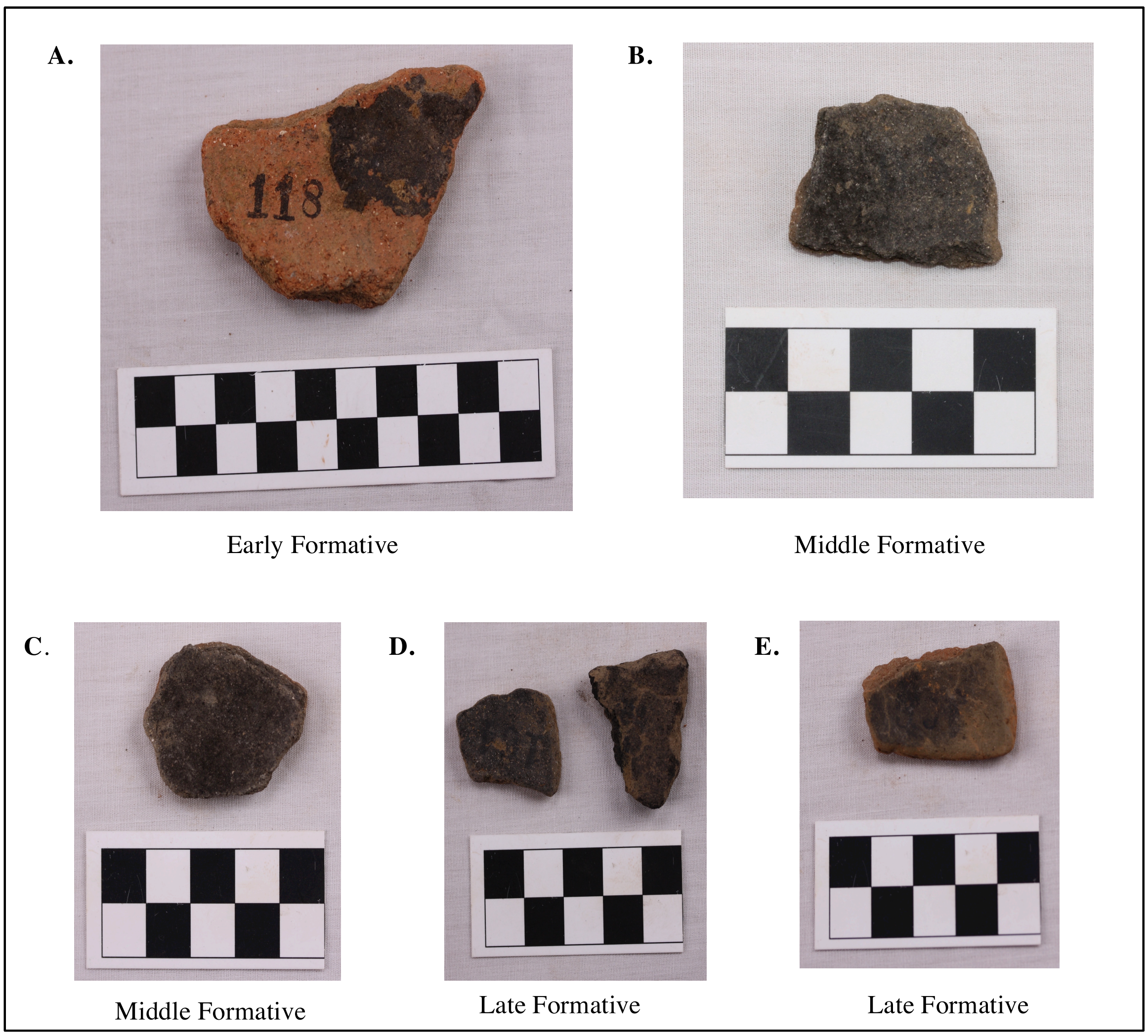

Figure 16. Ceramic samples with visible residues

collection includes ceramic representation for many occupational periods spanning the current historical time frame of La Venta. The use of new methodological and technological techniques can further perpetuate the current theoretical perspectives of Olmec archeology and the general knowledge acquired about the society and its influence.

Bitumen Source Analysis

The use and function of bitumen in Memsoamerican society have been documented to be varied and dependent upon geographical location and resource availability. Bitumen, characterized as asphalt, tar, pitch or chapopote (Mexico) is a naturally occurring petroleum substance that is defined as being chemically composed of complex natural hydrocarbons, and oxidized products (Wendt and Cyphers 2008: 178). The collection, processing, and use of bitumen in pre-historic and historic Mesoamerica are well defined from archaeological deposits, and ethnographic texts. In post-Olmec societies, bitumen has been documented for a variety of purposes including decoration, building construction, waterproofing, chewing gum, incense, body adornment, paint and fuel (Wendt 2004: 6). However, general knowledge about the use and function in Olmec contexts is still left to speculation. Further evidence needs to be provided by systematically controlled excavations.

In Mesoamerica, bitumen is found in a variety of occurrences along much of the central and southern portions of the Gulf Coastal plain as well as offshore in the Gulf of Mexico (Wendt and Cyphers 2008: 178). A large contortion of natural seeps lie directly in the vicinity of the Olmec centers of San Lorenzo, La Venta and Tres Zapotes (as indicated in Figure 17). The bitumen could be collected in a variety of locations and forms most likely being gathered on the surfaces of oceans or rivers, on beaches, in seeps, or in wells (Wendt and Cyphers 2008: 179).

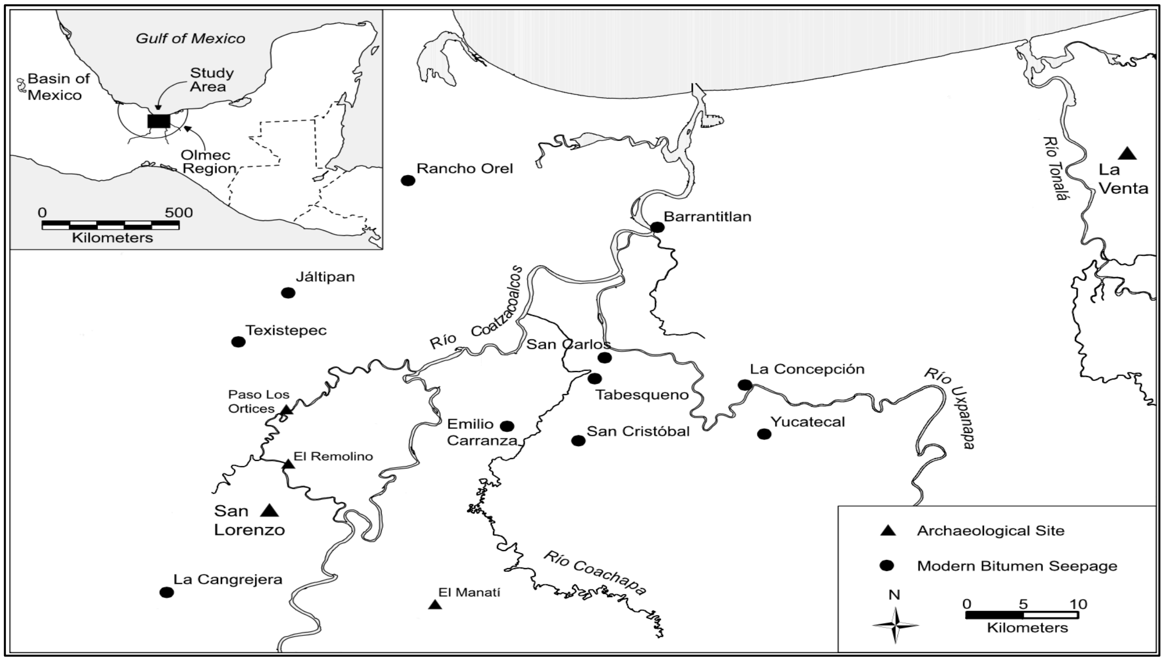

Figure 17. Southern Gulf lowlands with known bitumen seeps and principal archaeological sites (Wendt and Cyphers 2008: Figure 1)

Olmec groups would have controlled these natural sources as a principal commodity of exchange for groups throughout the Mesoamerican heartland. As with other commodities, the control, manufacture, and distribution of the substances would have direct implications on political and economic intentions in the area. If we classify the Olmec as a complex chiefdom, control and management of valuable commodities such as bitumen would have been directly affiliated with elite supervision and management (Wendt and Cyphers 2008: 176). The elite would manage the full systematic process from raw material extraction to its intended finished product regulating the social and political entities influenced by the commodity (Wendt and Cyphers 2008: 177).

According to Coe and Diehl (1980), bitumen's occurrence in the Olmec archaeological record suggest its primary function served as a waterproof sealant recognized in the construction of basalt aqueducts and probable use associated with water travel, an adhesive, a decoration in the form of paint, and as building material used to coat walls and floors of habitation structures (Wendt 2004: 5). There is an abundance of studies accounting for the presence of bitumen in context with archaeological materials recorded at Olmec sites. Rebecca González Lauck (1996) documents the use of bitumen on the U-shaped basalt aqueducts at the La Venta. Stark (1977) documented the adherence of bitumen to the inside of utilitarian vessels and indicates the bitumen was either collected or heated in the vessels themselves. The most intriguing use of bitumen from the Gulf Coast involves figurines, which appear to be decorated by a bitumen paint. The paint has been documented on the mouth, nose area, eyes, hair and headdresses of these figurines, which Engelhardt (1992) argues to be representative of an important aspect of a shaman's wardrobe (Wendt and Cyphers 2008: 180). Due to its relative abundance in the natural environment as well as its inscribed value as a principal commodity, the procurement and processing of bitumen need to be an actively researched question in the complex framework of Olmec exchange networks. By attempting to source archaeological examples of bitumen from a systematically excavated context, we can attempt to gain knowledge about relevant patterns of procurement, long distance trading, and ideas associating social complexity with Olmec groups as well as groups affiliated with the Olmec.

In a study completed by Wendt (2004), procurement strategies, regional exchange and interaction in the Olmec area were studied in relation to the use of bitumen. Specifically, the study was to obtain geophysical data to distinguish archaeologically defined specimens and their relation to specimens collected from local bitumen seeps throughout the Gulf Coast lowlands. The specimens were analyzed through Gas Chromatography/Mass Spectrometry to determine the chemically derived signature of both the specimens occurring in archaeological deposits as well as those collected from natural seeps (Wendt 2004: 3). The chemically derived signature consists of specific bitumen hydrocarbons, steranes and terpanes which function as a "fingerprint" distinguishing geophysical distinct characteristics (Wendt 2004: 5). Essentially, the efforts to source the bitumen will infer the possibilities of bitumen exchange, procurement, and use in regional economies. The study consisted of 15 archaeological samples as well as 10 field samples, that were analyzed using the same methodology and under the same conditions. The archaeological samples varied in form as seen in Figure 18. Of the 15 archaeological samples, 7 coincided with known bitumen seeps around San Lorenzo. However, of the remaining samples, similar source identifications seemed to group geographically. A challenging aspect of bitumen sourcing is the lack of known bitumen sources. More field research is needed to be accomplished in order to accurately correlate bitumen found in archaeological contexts with known bitumen sources in the Gulf Coast lowlands. However,

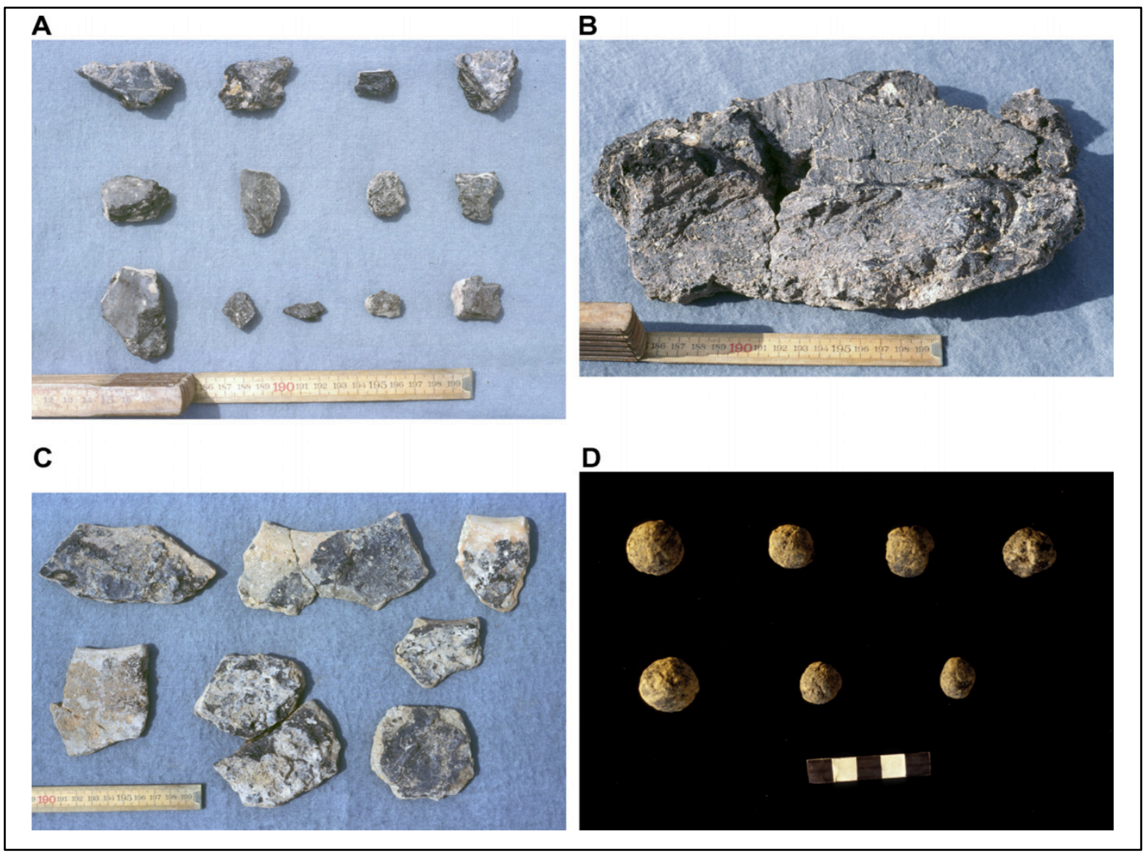

Figure 18. Different Forms of Archaeological Bitumen. (A) Amorphous lumps, (B) slab, (C) sherds with bitumen adherences, and (D) spheres (Wendt and Cyphers 2008: Figure 3)

since this was the first study ever undertaken on attempting to source bitumen in the Gulf Coastal lowland, it should stimulate the availability of future research to be continued.

The ability to run a successful bitumen source analysis is dependent upon the known sources of bitumen to which archaeological specimens can be correlated. Since this study dealt with bitumen in the immediate area of San Lorenzo, there is a strong possibility that populations were exploiting similar seeps in the area. Pit C of the 1964 collection yielded three specimens of archaeological bitumen (Figure 19). Since this is a rather small sample size, the entire collection needs to be analyzed in hopes to acquire more archaeologically defined examples of bitumen for source identification.

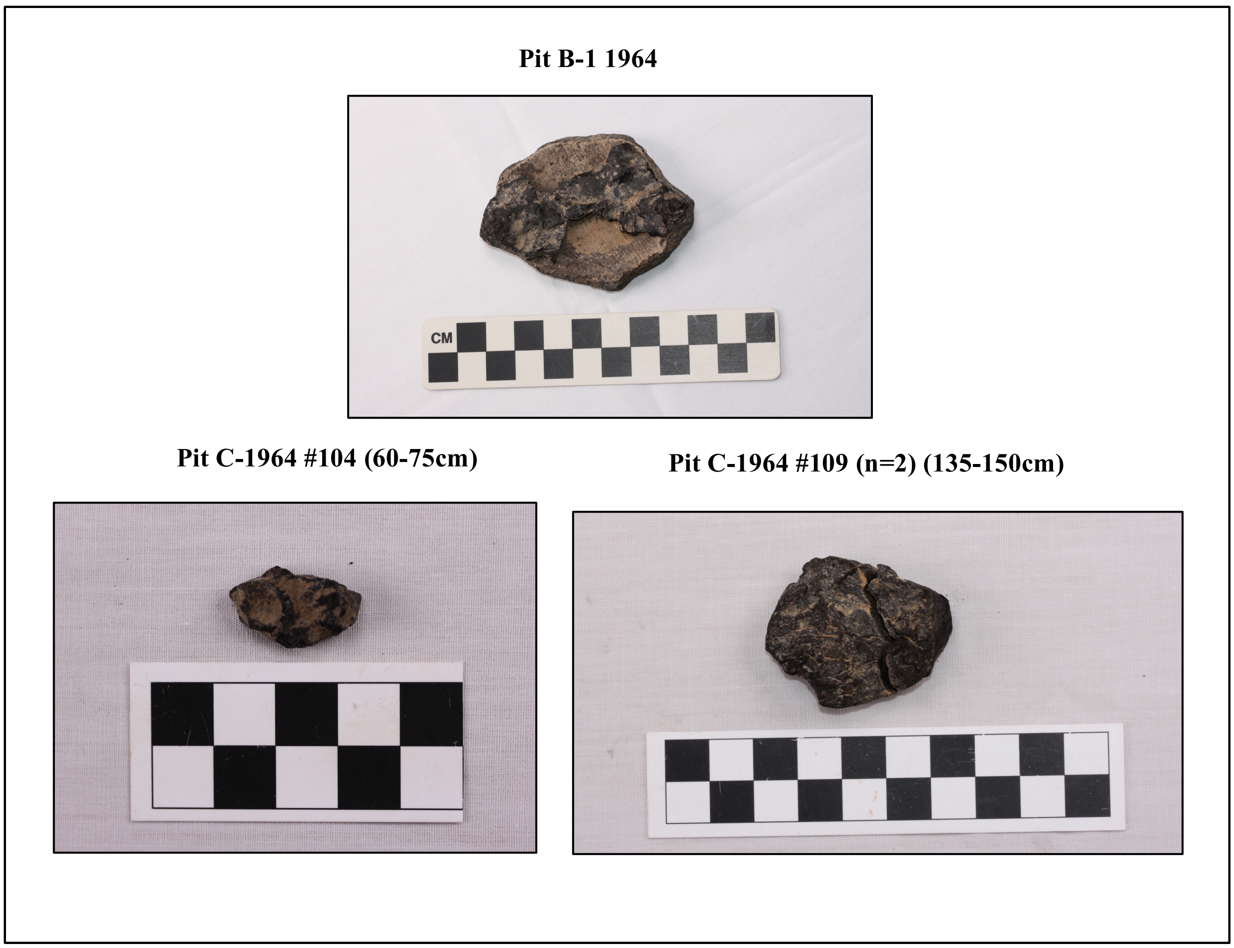

Figure 19. Bitumen samples of Squier collection

Chapter 7: Conclusions

The materials excavated at La Venta in 1964 by Robert J. Squier offer a unique opportunity to better comprehend the processes behind how archaeologists interpret Olmec culture, specifically, how they interpret activities at La Venta. In my opinion, the archaeological site of La Venta is one of the least understood of all the principal centers in the Gulf Coast lowlands. Due to contextual constraints, inferences about Olmec culture determined at other regional centers are difficult investigate. The disruption of archaeological contexts at La Venta due to the PEMEX-related activities have drastically affected the way in which archaeology needs to be approached there. I will now discuss each of my proposed objectives, and offer concluding remarks about the positions supported.

My first objective was to discuss the current theoretical interpretation of the Olmec and what they represented in the course of Mesoamerican history, most notably the way in which they have been classified and how their territorial control and influence on other groups has been interpreted. Without taking a specific position in regards to the Interregional Exchange Model, I think there needs to be far more evidence presented in terms of economic relations among groups at centers including La Venta in the Olmec heartland specifically focusing attention on highly valued goods obtained from distinct regions. Trade networks would have not only conditioned the exchange of goods themselves, but also of ideas, traditions, and beliefs. We need further evidence to support either position in the debate. The Olmec represented a group of settlements with a complex trading network controlled by an elite class. We need to compile more evidence about the actual control that elite individuals at La Venta and other centers had on other communities. The 1964 La Venta collection offers a unique opportunity to directly work with materials excavated at a principal center. The Olmec and Olmec-influenced neighbors in the

Gulf Coast lowlands and extending areas established trading networks that would have been a foundation on which later groups would base their own economic networks.

My second objective was to evaluate the potential that the 1964 La Venta collection offers for future research. Three avenues of research were suggested based upon the analysis and classification of materials from Pit C. However, the first step for establishing the possibility of future research is to classify and fully analyze all ceramics in the collection according to a type-variety system. Utilizing strategies employed by research completed by William Rust (2008) would be the best framework to correlate possible typological connections with ceramics from the site's hinterlands. Radiocarbon dates need to be obtained to ensure the credibility of the stratigraphic interpretations of the 1964 excavations. Ceramic residue analysis can offer evidence of subsistence remains utilized in a habitation area in the center. Residues with tobacco or cacao use would imply ritual- or elite-oriented activities. The last avenue of potential research involves bitumen sourcing. By understanding a regionally acquired product and the exchange networks associated with this good, we can further understand the complex trading networks in effect.

My third objective has been to address the current state of Olmec archaeology and issues associated with collection preservation and management. Through my own analysis, I was able to learn and demonstrate proper curation procedure and techniques through the curation of a significant archaeological collection. My work will offer the opportunity for others to continue research on the Olmecs, still an active component of Mesoamerican prehistory.

My final objective has been to evaluate and discuss the current state of Olmec archaeology with reference to preservation of archaeological sites and the preservation and utilization of past collections for future research. As discussed in Chapter 2, the current knowledge pertaining to the cultural activities at La Venta is problematic due to disrupted stratigraphic contexts. There is now greater interest in the analysis of long-distance trading networks and how they influenced relationships. Technological advances have made it possible to analyze the use and function of lithic and ceramic artifacts in order to better document, explain, and understand patterns. Older collections offer a unique opportunity to analyze materials with different theoretical goals than the ones driving the initial data acquisition. The 1964 La Venta collection has proven to be a valuable source of information about Olmec society.

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Appendix A

Archaeometry Laboratory

X-Ray Fluorescence Analysis of Middle to Late Formative Obsidian Artifacts from La Venta

MURR ANIDs: GBL001-GBL072

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This report describes the compositional analysis, source assignment, and interpretation of 72 lithic artifacts (GBL001-GBL072) excavated by Robert Squire in 1964 from Middle and Late Formative contexts at the Site of La Venta. One of the artifacts is not obsidian. Of the remaining 71 obsidian specimens we have identified seven separate obsidian sources, with the majority of the obsidian originating from the Paredon and San Martin Jilotepeque sources.

X-Ray Fluorescence Analysis

The ThermoScientific ARL Quant'X EDXRF was used for the analysis of these artifacts. The instrument has a rhodium-based X-ray tube operated at 35 kV and a thermoelectrically-cooled silicon-drift detector. The obsidian calibration uses a set of 37 well-characterized obsidian sources with data from previous ICP, XRF, and NAA measurements (Glascock and Ferguson 2012). The samples were counted for two minutes to measure the minor and trace elements present. The elements measured include Rb, Sr, Y, Zr, and Nb. These five elements are excellent for discriminating most sources.

Source Assignment Methodology

Statistical analysis was carried out on base-10 logarithms of concentrations. Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements such as iron and trace elements such as niobium. Transformation to base-10 logarithms also yields a more normal distribution for many trace elements.

The interpretation of compositional data obtained from the analysis of archaeological materials is discussed in detail elsewhere (e.g., Baxter and Buck 2000; Bieber et al. 1976; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000) and will only be summarized here. The main goal of data analysis is to identify distinct homogeneous groups in the analytical database and match these groups to the chemical signatures of known geologic sources. In most cases, source assignments for obsidian artifacts are based on visual inspection of elemental bivariate plots. XRF data tend to skew along correlation lines (largely as a function of variable sample mass), and visual inspection provides more reliable source assignments than some multi-variate techniques such as principal component analysis (Ferguson 2012).

Compositional groups can be viewed as "centers of mass" in the compositional hyperspace described by the measured elemental data. Groups are characterized by the locations of their centroids and the unique relationships (i.e., correlations) between the elements. Decisions about whether to assign a specimen to a particular compositional group are based on the overall probability that the measured concentrations for the specimen could have been obtained from that group.

Source Assignments

Appendix one includes the compositional data for the 72 specimens along with their source assignments. Two of the obsidian pieces were slightly outside the typical compositional variability of known sources, but we a reasonably confident in their assignment. These include

GBL001 – assigned to the Otumba source, and GBL016 – assigned to San Martin Jilotepeque. Figure 1 is a scatterplot of the artifacts against the ellipses for the source samples.

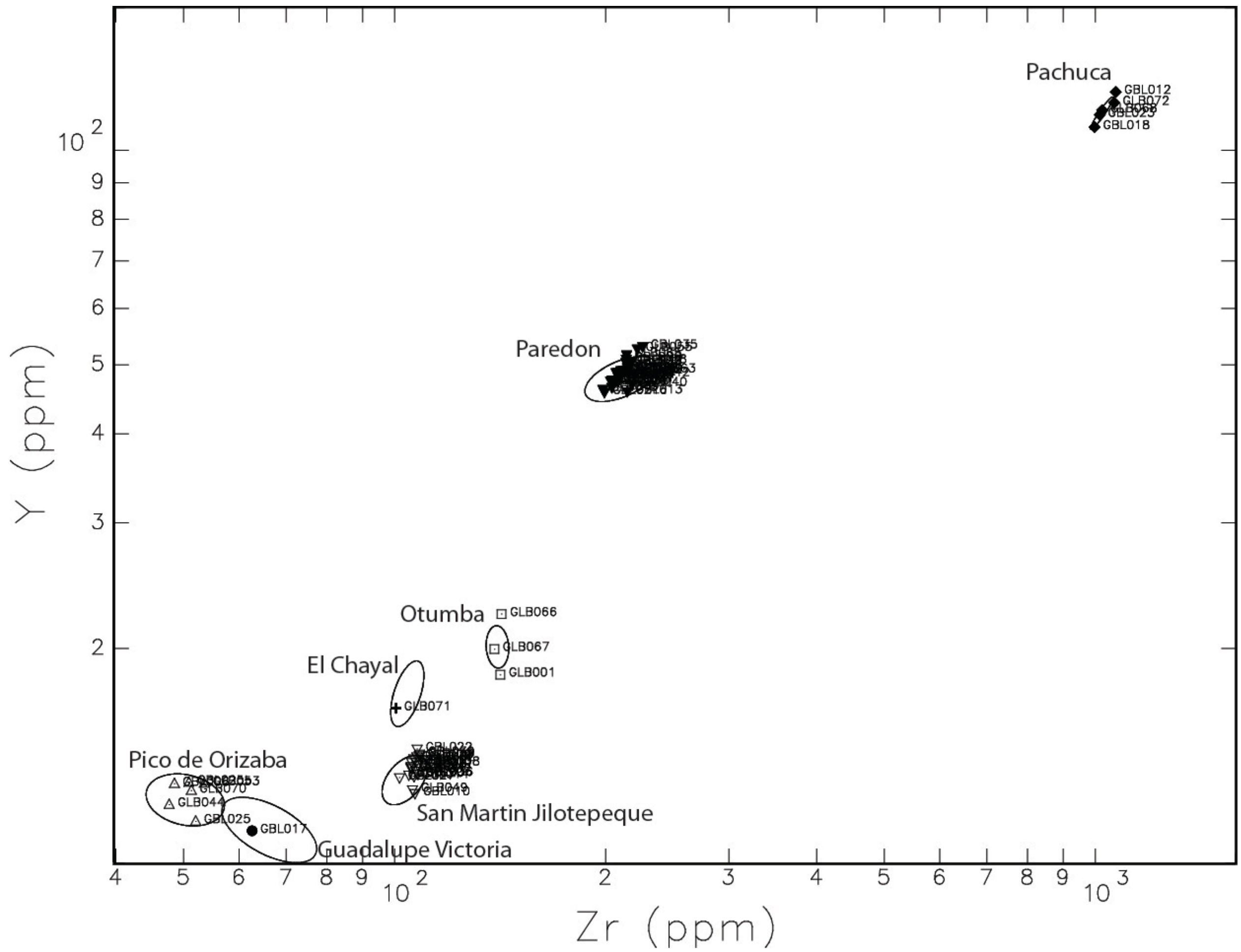

Figure 1: Scatterplot of zirconium and yttrium concentrations for the obsidian artifacts and sources. Artifacts are individually plotted and labeled. Sources are represented by ellipses only. Ellipses represent 90 percent confidence intervals for membership in the groups.

The Pico de Orizaba and Guadalupe sources can be difficult to differentiate and are not clearly separated in Figure 1. Figure 2 shows only these two sources and the artifacts assigned to them.

Overall, 48% (n=34) of the obsidian artifacts are assigned to Paredon, 31% (n=22) to San Martin Jilotepeque, 7% (n=5) to Pachuca, 7% (n=5) to Pico de Orizaba, 4% (n=3) to Otumba, and 1% (n=1) each from El Chayal and Guadalupe Victoria.

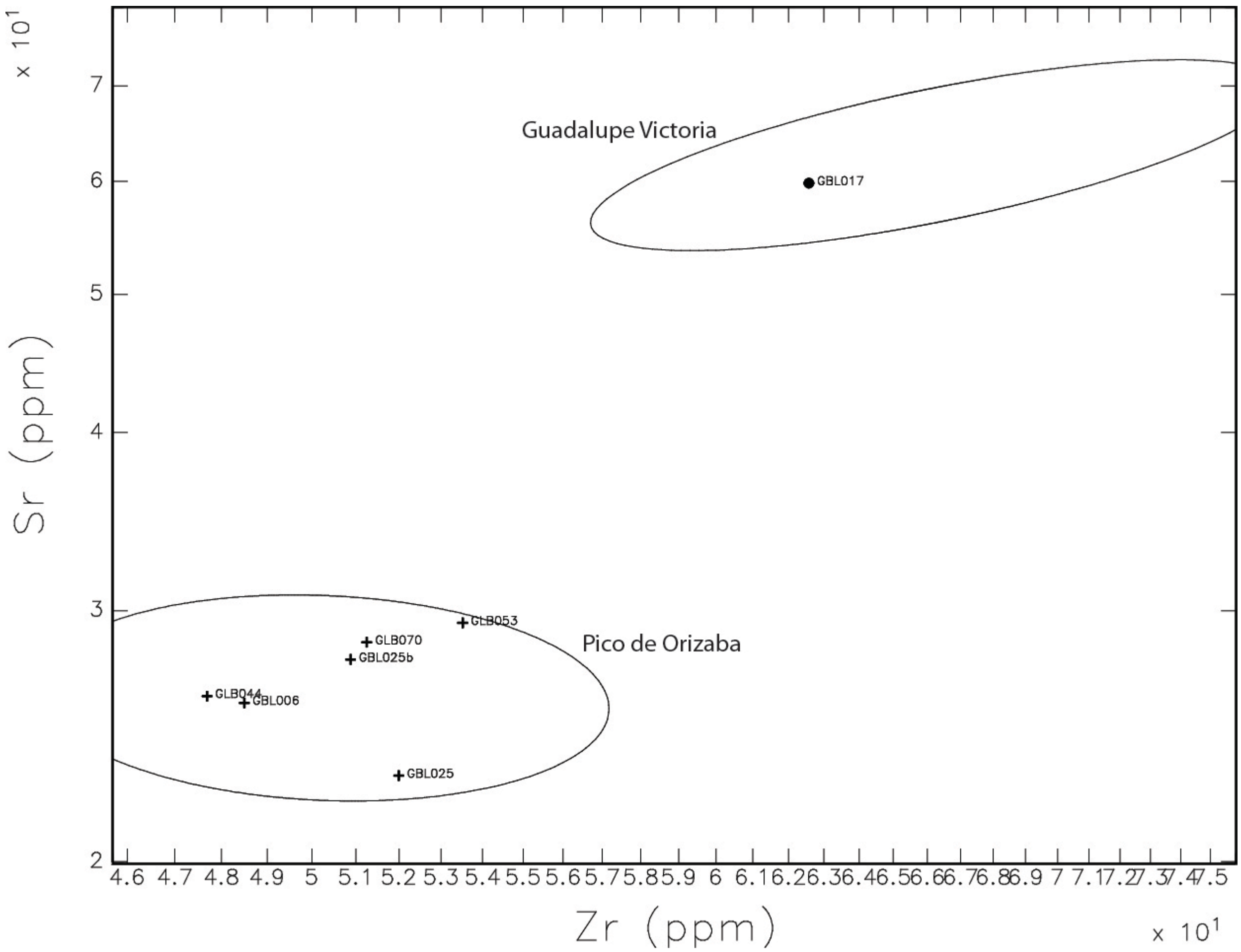

Figure 2: Scatterplot of zirconium and strontium concentrations for Pico de Orizaba and Guadalupe Victoria sources and assigned artifacts. Artifacts are individually plotted and labeled. Sources are represented by ellipses only. Ellipses represent 90 percent confidence intervals for membership in the groups.

Internal Patterns

Table 1 reveals the breakdown of source use by time period. Most of the sources have so few artifacts that temporal patterns are not meaningful, but there is a notable shift to greater Paredon use during the Middle Formative.

There are similar sample size issues when examining artifact types by sources. Most sources have few artifacts assigned to them and thus patterns are difficult to determine. It is worth noting that the heavily modified gaming piece is from Pachuca. In comparing San Martin Jilotepeque and Paredon there is a greater frequency of blades from San Martin and greater presence of flakes and flake tools from Paredon. Perhaps this indicates greater importation of blades from San Martin and greater on-site reduction of Paredon obsidian.

Table 1: Breakdown of assemblage by source and time period.

Period	El Chayal	Guadalupe Victoria	not obsidian	Otumba	Pachuca	Paredon	Pico de Orizaba	San Martin Jilotepeque	Grand Total
Late Formative		1		1	3	12	2	12	31
Middle Formative	1		1	2	2	22	3	10	41
Grand Total	1	1	1	3	5	34	5	22	72

Table 2: Breakdown of assemblage by source and artifact type.

Artifact type	El Chayal	Guadalupe Victoria	not obsidian	Otumba	Pachuca	Paredon	Pico de Orizaba	San Martin Jilotepeque	Grand Total
Bifacial Tool						2			2
Blade						1			1
Blade Fragment		1		1	1	17	1	17	38
Flake	1		1	1	3	12	4	2	24
Gaming Piece					1				1
Shatter				1		2		3	6
Grand Total	1	1	1	3	5	34	5	22	72

Conclusions

Of the 71 obsidian artifacts submitted for analysis (one additional artifact was determined to not be obsidian) all are assigned to known sources, although there are two with slightly increased compositional variability. The assemblage reveals the use of primarily Paredon and San Martin Jilotepeque obsidian with decreasing Paredon use during the Late Formative, and some evidence of greater importation of manufactured blades from Sam Martin Jilotepeque. Previous studies at La Venta have noted approximately 10-15% of the assemblage from the Zaragosa source that is not present in this assemblage.

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Appendix 1: Compositional data and source assignments for all artifacts in the study.

ANID	Source	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb	Th
GBL001	Otumba*	619	8322	42	134	150	18	142	13	12
GBL002	Paredon	396	9167	50	182	5	50	214	43	21
GBL003	San Martin Jilotepeque	557	6542	31	114	178	13	108	9	9
GBL004	Paredon	384	8601	47	172	4	47	203	40	21
GBL005	Paredon	402	9664	55	181	6	49	215	44	19
GBL006	Pico de Orizaba	661	4205	24	114	26	13	48	13	7
GBL007	Paredon	407	9847	50	180	5	49	207	42	20
GBL008	San Martin Jilotepeque	601	7365	34	121	188	14	110	9	8
GBL009	San Martin Jilotepeque	582	7357	41	120	187	14	108	8	8
GBL010	San Martin Jilotepeque	579	7477	43	121	188	13	107	10	11
GBL011	San Martin Jilotepeque	606	6991	36	120	187	14	108	11	10
GBL012	Pachuca	1287	18934	263	234	3	121	1070	92	25
GBL013	Paredon	374	8151	48	167	4	46	215	42	21
GBL014	San Martin Jilotepeque	585	6992	33	115	181	13	107	9	10
GBL015	San Martin Jilotepeque	584	7295	30	117	184	14	107	10	9
GBL016	San Martin Jilotepeque*	751	10245	37	131	195	16	129	10	11
GBL017	Guadalupe Victoria	563	4629	24	95	60	11	63	12	9
GBL018	Pachuca	970	17934	210	204	3	108	997	90	19
GBL019	San Martin Jilotepeque	550	6986	31	119	185	14	107	8	9
GBL020	San Martin Jilotepeque	574	6941	32	123	181	13	105	9	11
GBL021	Paredon	357	8121	39	165	5	46	199	40	17
GBL022	San Martin Jilotepeque	583	7300	32	118	183	14	108	11	10
GBL023	Pachuca	1149	17595	214	212	3	112	1014	91	20
GBL024	Paredon	392	8884	44	175	6	48	210	41	20
GLB025	Pico de Orizaba	714	5195	23	118	28	13	51	12	7
GBL026	Paredon	390	9333	53	182	5	51	214	43	20
GBL027	San Martin Jilotepeque	568	6681	28	119	177	13	102	8	9
GBL028	Paredon	401	9601	52	184	6	50	215	43	20
GBL029	Paredon	369	8325	47	169	5	47	204	42	19
GBL030	Paredon	353	8777	46	179	6	50	214	43	20
GBL031	Paredon	379	8625	51	175	5	48	209	42	20
GBL032	Paredon	397	9269	56	179	6	49	215	43	18
GBL033	Paredon	373	9155	48	186	5	49	212	42	21
GBL034	Paredon	374	8603	45	174	5	48	210	42	19
GBL035	Paredon	510	13315	77	205	6	53	226	43	22
GBL036	San Martin Jilotepeque	603	7408	30	120	186	13	108	10	9
GBL037	San Martin Jilotepeque	575	7464	30	117	184	13	107	10	8
GBL038	San Martin Jilotepeque	568	6483	24	119	179	14	106	11	11
GBL039	San Martin Jilotepeque	622	7339	35	122	190	14	109	10	10
GBL040	Paredon	380	8352	45	170	5	47	218	41	19

GLB041	Paredon	395	9138	54	187	5	49	215	43	20
GLB042	Paredon	379	9016	47	177	6	48	220	43	21
GLB043	Paredon	379	8570	47	177	5	49	210	42	19
GLB044	Pico de Orizaba	636	4074	20	108	26	12	48	11	7
GLB045	Paredon	372	8498	40	165	5	46	198	40	18
GLB046	Paredon	387	9087	47	176	5	49	210	42	18
GLB047	Paredon	402	9829	51	185	5	51	216	43	21
GLB048	Paredon	398	8957	43	175	5	49	208	43	20
GLB049	San Martin Jilotepeque	570	6953	28	118	181	13	106	9	9
GLB050	Paredon	393	8774	43	171	5	47	206	41	17
GLB051	Paredon	365	8455	42	170	5	47	206	43	20
GLB052	San Martin Jilotepeque	560	7085	30	116	182	14	106	10	10
GLB053	Pico de Orizaba	837	5646	27	130	29	13	54	13	8
GLB054	San Martin Jilotepeque	555	6819	28	117	181	14	105	10	10
GLB055	Paredon	407	10077	57	196	5	53	222	42	21
GLB056	Paredon	389	8997	44	175	6	48	208	41	19
GLB057	Paredon	399	8901	49	174	5	46	204	41	19
GLB058	Paredon	428	10259	54	191	5	51	218	43	22
GLB059	San Martin Jilotepeque	668	7772	31	123	192	14	108	9	10
GLB060	San Martin Jilotepeque	583	6806	28	118	184	14	106	10	9
GLB061	Paredon	355	8594	46	171	5	47	208	41	20
GLB062	San Martin Jilotepeque	598	7245	30	122	191	14	109	8	8
GLB063	Paredon	400	9397	50	183	6	49	225	43	22
GLB064	Paredon	377	9190	48	177	6	48	204	42	21
GLB065	Paredon	405	9494	56	190	6	52	214	44	21
GLB066	Otumba	453	12566	50	150	138	22	142	14	12
GLB067	Otumba	411	8625	34	122	119	20	139	13	11
GLB068	Pachuca	1130	16731	211	213	3	114	1023	92	21
GLB069	not obsidian	200	1733	3	0	17	0	3	2	0
GLB070	Pico de Orizaba	717	4859	25	123	28	13	51	13	8
GLB071	El Chayal	632	6096	31	145	136	16	100	10	12
GLB072	Pachuca	1175	17885	229	222	3	117	1064	95	23